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A
REPORT
ON
THE TEMPLES OF PHILÆ

BY

Captain H. G. LYONS, D.Sc., F.R.S.,
DIRECTOR-GENERAL, SURVEY DEPARTMENT.

Price 200 Milliemes.

CAIRO:
National Printing Department,
1908.

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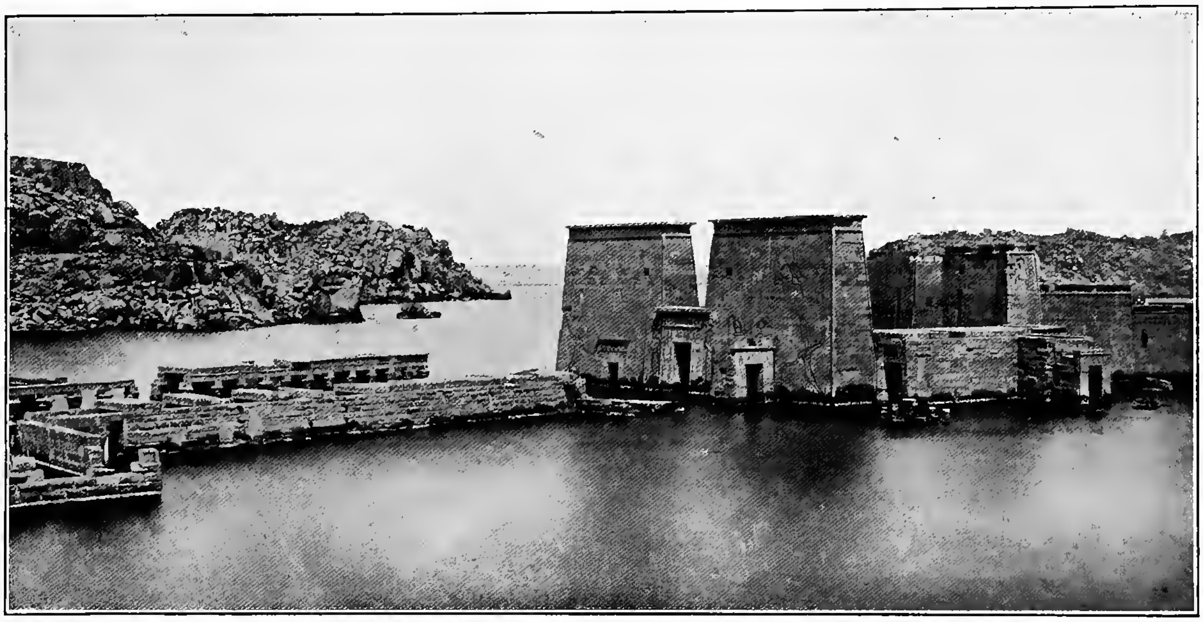
PHILÆ TEMPLE.



View from the south-east when Reservoir is full.

Survey Dept. Cairo, 1908.

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LIST OF PLATES.

PAGE.

I. Philæ from the east when the Reservoir is full .. Frontispiece

II. The Colonnades from the east .. 28

III. Temple of Trajan (Pharaoh's Bed) .. 28

IV. Plan of the island of Philæ .. At end.

V. General plan of principal temples showing portions which have been underpinned . ,,

VI. Temple of Nectanebo II. .. ,,

VII. West Colonnade (southern half) .. ,,

VIII. ,, ,, (northern half) .. ,,

IX. East Colonnade .. ,,

X. Eastern Annexe of Temple of Isis .. ,,

XI. Temple of Isis Usret (The Mammiseum) .. ,,

XII. Hadrian's Gateway .. ,,

Temple of Hathor .. ,,

XIII. Temple of Trajan (The Kiosk, or Pharaoh's Bed) .. ,,

XIV. ,, ,, ,, ,, ,, ,, .. ,,

INTRODUCTION.

The Temples of Philæ, which were partially submerged for the first time at the beginning of 1903, have since been subjected to five additional immersions. The Ministry of Public Works decided that a careful examination should be made of the buildings in November, 1907, in order to collect as much information as possible concerning any deterioration that might have taken place since the reservoir was filled for the first time.

The present report contains the result of this examination.

An account is given of the works of consolidation and conservation which were carried out in 1901 and 1902 by Dr. J. Ball, the engineer in charge of the work, in order to show the condition of the buildings and their foundations before the rise of the water in the reservoir. This may be well seen in the plans which were prepared by Dr. Ball in 1901.

The state of the buildings in 1907 has been described by Mr. E. T. Richmond, Director-General of the Department of State Buildings, from the examination of them which he then made.

The chemical investigations into the nature and quality of the stones, the efflorescent soils, the alluvial deposits and the river water, were carried out by Mr. A. Lucas, F. I. C., in the Laboratories of the Survey Department.

It is hoped that the present report furnishes sufficient information to enable others to realize how entirely satisfactory the work of consolidation is, which was carried out in 1901 and 1902.

A REPORT ON THE TEMPLES OF PHILÆ.

Eleven years ago the construction of the Aswan Reservoir was decided upon, and the effect which submersion would have upon the buildings on Philæ Island became a problem of importance, but it was not then possible to give a complete solution; all that could be done was to take every precaution in order to ensure the preservation of the buildings.

With this object, the buildings were thoroughly examined, both above and below ground, and a large amount of work was carried out to ensure their stability, while the rubbish of the old mud-brick villages, which contained a considerable amount of salt, was removed. Since the completion of these operations, the Reservoir has been filled five times, and their efficacy has been tested by the submersion of the island and of a portion of the buildings on it; it is therefore possible to form an opinion of the present condition of the buildings, to gauge the changes which have taken place in them, and to estimate with some degree of probability what the effect of further submersion will be.

During these five years, reports upon the condition of the buildings have been published from time to time,* and these have spoken favourably on each occasion of the results obtained by the works of consolidation which were carried out in 1902. Nevertheless, statements have been made that the temples are deteriorating; that their stability is doubtful under the present conditions; and that within a few years the stone will have become disintegrated by its annual submersion.

No reliable evidence has been brought forward to support such pessimistic predictions, but the recent decision to raise the Aswan Dam in order to hold up a greater store of water in the Reservoir will undoubtedly increase any forebodings of disaster which have been caused by such statements. It is desirable, therefore, in addition to calling attention to the favourable reports which have already been made, to set forth the results of a careful examination of all the buildings which was made in the first week of November, 1907; it is also of especial importance to publish the information which has been accumulated during the past few years on the character and composition of the stone of which the buildings are constructed, on the chemical composition of the Nile water, and of the salts which are found in the village rubbish, as well as in the stone itself.

This examination has wholly confirmed the earlier reports of the stability of the buildings, and the collection of facts which are included in the present report will enable those who are interested in the Island of Philæ to form an opinion of the present condition of the buildings, and of the probable effect of further submersion. The chemical and geological evidence provides a more definite basis than has yet existed for forming an adequate judgment on these questions.

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* *Annales du Service des antiquités de l'Egypte.* Vol. IV, pp. 244-247, 1903; Vol. V, pp. 250-264, 1904; Vol. VII, pp. 71-77, 1906.

Previous to the construction of the Dam, the level of mean low Nile stood at about 91 metres, and that of exceptionally high floods at about 99 metres above mean sea-level, so that about eight metres of the sandstone quay-wall have been alternately wet and dry for twenty centuries; yet no better preserved stone is to be found anywhere on the island than that which is in these walls.

The modified scheme for the Reservoir entailed raising the maximum water level to 106 metres above sea-level, which height the water would reach about the end of January, while the lowest level of the water would occur in November, just before the filling of the Reservoir commenced; the water level would then be about 97 metres above sea-level, so that the permanent saturation level of the ground upon which the buildings stand was to be raised from 91 to 97 metres, and the high-water level from 99 to 106 metres.

The levels of the floors of the principal buildings are as follows: the Temple of Isis Usret, 104·20 metres; the Temple of Isis, 106·20 metres; the Temple of Hathor, 105·00 metres; Pharaoh's Bed (or the Temple of Trajan), 104·40 metres; the East Colonnade, 103·00 metres; the West Colonnade, 102·80 metres, above sea-level, so that all except the Temple of Isis are partially submerged when the Reservoir is full and its water level reaches 106·00 metres.

CONSOLIDATION AND CONSERVATION.

Two examinations of the temples were made, the first in 1895–1896, and the second in 1901; full particulars of the nature of the ground and the character and depth of the foundations were obtained by sinking shafts down to the foundation beds of the various buildings.

The soil which overlies the uneven granite surface of the island was found to consist of ordinary fine Nile mud for the top three or four metres, below which it became more sandy; by the time saturation-level was reached, clean, sharp river-sand, free from clayey matter, was always present. In 1895–1896, the rubbish derived from the mud-brick buildings of Coptic or later date was removed, and an examination was made of the foundations of the temples, the colonnades, and the other ancient structures on the island; the Coptic buildings were cleared out and left for study, and plans were prepared of the buildings, photographs being taken to record their condition at that time.* In 1898, a topographical survey was made of the reach of the valley, from Aswan to Korosko, which would be wholly or partly flooded by the Reservoir, and the maps (36 sheets) were published in 1899 on the scale of 1 : 10,000.

This examination of the temples in 1895–1896 showed that while the main part of the Temple of Isis rested on granite rock, the forecourt and other buildings had been built upon the Nile alluvium deposited on the uneven granite mass which forms the core of Philæ Island, but further information was necessary before the work of consolidation could be commenced.

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* "A Report on the Island and Temples of Philæ," Cairo: 1896.

In 1901, when the Reservoir works were approaching completion, the subject of strengthening and consolidating the buildings was taken up, and studied in order that the change of physical conditions entailed by a partial submergence annually might cause as little damage as possible to the structures and their inscriptions.

The work was carried out under the general direction of Mr. Fitzmaurice, the Resident Engineer of the Aswan Dam; Dr. J. Ball, of the Survey Deparment, was employed to carry out the exploratory work and to prepare designs and estimates of the cost of executing it; Mr. Mat Talbot was specially engaged by the late Sir Benjamin Baker as an expert for the sinking of the necessary shaft and all underground work. The total expenditure on this work was L.E. 13,839.*

In order to understand the present condition of the temples, it is necessary to know what was done in 1901 and 1902: the summary which follows (pp. 7-16) has been extracted from the Report of Dr. J. Ball, the engineer in charge of the work (lent by the Survey Department) and reproductions of the plans which were drawn by him on the scale of 1 : 50 are given on Plates IV-XIV.

Between April and June, 1901, the foundations of all the more important buildings on the island were thoroughly investigated. Small rectangular shafts, about 1·3 metres by 1 metre, were sunk by the side of the building to be examined, and were carried down in several cases to a depth of 13·0 metres; trenches were also dug and headings driven wherever it seemed probable that useful information would be obtained by doing so. This examination furnished a large amount of valuable information, which is incorporated in the plans and sections of the buildings (Plates IV-XIV), and indicated the depth at which the granite rock of the island was met with. The old foundations generally descend two metres or more below the ground, and, though sometimes irregularly laid, they consisted of large blocks which formed a good base under the conditions which had existed previously. Little mortar was used between the blocks, but, in accordance with the Egyptian practice, plaster was spread on one or sometimes two roughened mortar beds on the upper face of the block, but the outer margins of the blocks of each course were in contact. Thus, close joints occur everywhere, and the faces of the walls when finally dressed presented a smooth unbroken surface on which the inscriptions might be carved. In the foundations, the close-fitting of the blocks was not so strictly attended to; the outer faces of the blocks are rough-dressed, and project unequally from the face of the wall. The courses are usually about 0·50 metre in thickness, though occasionally some as thick as 0·65 metre, and others not more than 0·35 metre occur.

The ground at the surface is ordinary Nile deposit, a very fine sandy mud which coheres on drying, but, lower down, the character of the alluvium changes, becoming more and more sandy, until, at the level of 92 metres above sea-level, it consists of a fine clean river-sand which continues down to the rock. The rock, which generally occurs several metres below saturation-level, is the normal red granite of the district, usually but little decomposed, and presenting a rounded and uneven surface.

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* Report Public Works Ministry, 1901, pp. 241-245. Cairo: 1902.

Experiments made by means of a pile 6 inches square resting upon a horizontal surface of Nile silt at saturation-level showed the resistance of the silt to pressure to be as indicated in the table below:—

Loads.		Results.
In tons per square inch	In kilogs. per square cm.	
2·36	372	Settlement ceased after 3 hours.
3·56	561	Settlement of 3 millimetres in 12 hours.
4·76	750	Settlement of 36 millimetres in 12 hours but no further movement.

As a result of these examinations, it was decided to underpin all the ancient buildings whose foundations did not reach the level of permanent saturation, and to carry such underpinning down to this level except in the case of the Great Pylon of the Isis Temple, where the foundations were very broad and to a large extent surrounded by other buildings.

The pressure on the underpinned foundations of the Kiosk, or Temple of Trajan, is about 2·7 kilogrammes per square centimetre (2·5 tons per square foot), and that of the Great Pylon 4·4 kilogrammes per square centimetre (or 4 tons per square foot).

At first, a trench 1 metre wide was opened down to the level of the base of the existing foundations; it varied in length, and in some cases was carried round the entire building before entering below. Below the level of the bottom of this trench, excavation was only carried on in short lengths, varying from 1·5 to 3 metres, and the points of simultaneous underpinning were carefully distributed round the building in such a way as to allow of convenient progress while not endangering the superstructure by having too large an extent on timber at once. A short length of the trench was then carried down about 1·5 metres further, and an entry was made transversely under the old wall. At starting, only sufficient earth was excavated to allow of the first set of timber being inserted. The deepening of the shaft and heading was carried out in metre depths, stout timber frames being inserted to support the masonry, until the saturation level was reached, when the bottom was levelled and prepared for the new masonry.

All stone of size suitable for underpinning had been stacked as the removal of the Coptic village proceeded, and these stacks formed the only source of the stone used. About one-third or more of the stone was in roughly-dressed small blocks, 30 to 50 centimetres long, about 30 centimetres wide, and 15 to 35 centimetres in thickness, the remainder being rubble. The stone was nearly all sandstone of good quality, but included a small proportion of granite rubble. The mortar used in the work was 3 parts of a very coarse, sharp sand to 1 part of Portland cement.

Wherever the irregular granite boulders formed the bottom, the interspaces were first raked out and the rock washed clean, then filled with mortar and spalls embedded until a level base was obtained on which the work proceeded regularly. The best-dressed stones were kept for the outer face, as it was found that, in the confined space, with an irregular foundation above, it was difficult for the men to maintain a proper thickness unless the outer face was fairly plane. The final junction with the old work was made by driving thin granite spalls as wedges between the new work and the old.

As the underpinning of successive lengths was accomplished, the outside shafts, which formed the means of access for inserting the masonry, were left open, so that, on the completion of the entire length of any one side of a building, a deep timbered trench, extending down to the base of the underpinning, remained open and required to be filled. In order to secure solidity in this filling and to avoid any considerable settlement of the earth later on, and at the same time to keep the masonry wetted while the mortar was setting, the filling consisted mainly of waste stone, with just enough earth to fill all voids and form a solid mass, and the whole was abundantly supplied with water. The stone, earth, and water were all thrown in from the top, the height of the fall ensuring thorough consolidation of the mass. After a few days, the mass had hardened into a sort of rude concrete owing to the cementing nature of the Nile silt.

TEMPLE OF NECTANEBO.

(*Plate VI.*)

The exploratory excavations showed this temple to be partially founded on ancient walls of the same character as the counterforts of the quay wall. The positions of these walls are shown on the plans; they descend to the rock, which is here at an average level of about 9 metres. It is evident from the plans that these deep walls belong to an earlier age than the temple itself, which latter was in fact placed askew to them in such a manner that parts of the west side and north end were unsupported except by stone beams spanning the spaces between them. The floor of the temple consisted likewise of stone beams covering the space between the old walls. Owing to subsidence of the ground within the cell-like spaces, which thus removed any support to the central part of the floor from below, these flooring-beams were mostly found broken and sunk, being prevented from dropping further by the jamming of their ends. An air-space existed here, as at the south end of the colonnades, between the floor and the earth below it. The effects of subsidence are specially marked in the inward leaning of the columns of the north end of the temple, on either side of the doorway.

It was decided to treat this building on the same principle as the West Colonnade, by introducing steel girders surrounded with masonry between the old walls, and packing up to the superstructure. On the west side, the two excavations were made outside the temple, to a depth of 1·5 metres below the base of the stone beams, and the girders were inserted and built in as in the colonnade.

The only remaining part requiring support was the floor, the stones of which had broken and sunk. An excavation was, therefore, made to a depth of 1·35 metres in the entire space between the three walls, and four lines of 56 lb. steel rails, each line of two overlapping lengths, were put in. These rested at the two ends on the steel girders and in seats cut into the quay wall respectively, while at the centre the overlapping ends were taken by another 14 inch by 6 inch steel girder placed across the building. The dropped ends of the flooring stones having been carefully jacked up into an approximately horizontal position and securely propped, masonry was commenced at the quay-wall end and gradually carried northwards, props being removed as the work proceeded, and granite packings being driven in cement between the top of the new work and the base of the old.

THE WEST COLONNADE.

(*Plates VII and VIII.*)

The West Colonnade is much longer than the eastern one, containing 32 columns, all of which, except the one at the south end, were finished. Three of the columns have now partially disappeared.

The exploratory excavations in the colonnade revealed an unexpected form of construction, in the shape of a large number of counterforts to the quay-wall. These counterforts are generally about 2 metres in thickness, spaced on the average about 3 metres apart in the clear, and descend in all cases to a great depth, when they do not actually reach the bed-rock. They are built of large roughly-dressed blocks of sandstone in 50-centimetre courses, laid without mortar, and extend in all cases past the line of the columns, being met at the south end of the colonnade by a wall-running north and south, so that a series of closed cells is formed. The outer quay-wall is mostly built on rock, though where this lay low the space has been made up with granite boulders in order to furnish a base for the wall. The part of the wall opposite columns 7 to 11 was obviously built for a quay at an earlier date than the remainder; it is not quite in line with the adjacent parts, and moreover its string course shows the flat curvature which is seen in the quays of the Temple of Hathor and the Kiosk, while the inclined joints which mark the side-limits of the quay are clearly visible from the outside of the wall.

The colonnade itself, 77 metres in length, has been built quite independently of the foundations below it, as the spacing of the columns bears no relation to that of the supporting counterforts. The spaces between the counterforts are bridged over by sandstone beams 50 centimetres thick, over which another course of similar thickness was laid to receive the column bases. Thus, except where a column happens to stand over a counterfort, the whole weight of the columns and their load of lintels came on these beams, with the natural result that they are fractured almost without exception. In addition, the earth within the cells at the south end has settled, so that on opening up, it was generally possible to crawl into the spaces below the colonnade.

The outer quay wall is subjected to a slightly increased pressure at the time when the Reservoir level falls and the earth behind it is saturated; but its mass is great enough to prevent failure from this cause. The counterforts, too, are in all cases founded below saturation-level, and are thus secure. It was therefore decided to support the whole colonnade on steel girders, spanning the spaces between the counterforts, the space between the tops of the girders and the under-side of the stone beams being packed with masonry in cement. In addition, the girders were surrounded with a mass of masonry in cement to prevent access of water.

The openings were made at the outside face of the colonnade (*i.e.* east of the columns) between the counterforts. At the south end it was necessary to remove some thick paving stones in order to effect an entrance. A trench one metre wide was taken out to a depth of 1·5 metres below the base of the existing stone beams, and timbered with boards and walings stretched between the counterforts. In each bay two rolled steel girders, 14 inches by 6 inches, by 54 lbs. per foot, were placed on cement seatings, 50 centimetres apart from centre to centre, so as to be centrally under the line of columns. Rubble masonry, in 3 to 1 Portland cement, was then built into the seating-spaces and into the entire excavation, to a distance of one metre outside the centre line of columns. The packing between the girders and the stones above was done with thin granite spalls, hammered into the cement. In some cases, where the stone beams were fractured and extended further outwards than the normal distance, small additional masonry piers were built on to the main mass to support them. No attempt was made to restore sunken portions of the beams to position, as this would have been attended with some risk, without resulting in any great advantage; the underpinning has therefore preserved the colonnade precisely as it was found, with the addition of security against further damage.

After the underpinning was accomplished, the whole foundation was thoroughly grouted, both from the outside face (where suitable channels were formed in the masonry) and from the top. Holes were drilled through the stones between each pair of columns, and cement grout run in till no more was taken. In all, very nearly 4 tons of cement were consumed by this grouting.

THE EAST COLONNADE.

(*Plate IX.*)

This colonnade is about 42 metres in length. It contains 17 columns, 16 of which were built on a nearly continuous wall averaging 2·25 metres wide at base and 2·4 metres deep below pavement-level. As the pavement is 103 metres above sea-level, there was a thickness of about 3·6 metres of silt between the base of the old foundation and the saturation-level, except at the south end, where the granite rock rises very nearly to the base of the old masonry, though nowhere touching it; at the north end the rock is about 13 metres below the surface, or 7 metres below the saturation-level.

The wall east of the columns, which carries the eastern ends of the roof blocks, was on a shallower foundation than the columns, descending to an average of only 1·4 metres below pavement-level; it was also much narrower, spreading out to an average width of only 1·4 metres. The rock-surface under this wall runs about parallel with that under the columns.

The underpinning here consists of two continuous walls of rubble masonry in 3 to 1 Portland cement, that under the columns being 2·5 metres thick, and that under the wall 1·5 metres. The walls extend in both cases down to saturation-level, except where rock was met with above that datum.

The underpinning was accomplished in lengths of about 2 metres, of which three were generally kept going at once at different points. The first excavations were got out from the outside (*i.e.* the west side) of the colonnade, so as to avoid going through the pavement within; but as this pavement was very roughly put in, it was soon found better to remove it (*see* p. 18) and sink down between the columns and the wall, driving headings east and west simultaneously and thus accomplishing the underpinning of both colonnade and wall at one operation. The foundation of the eastern wall being built of small indifferently laid stones, a few stones from the bottom course were taken out and replaced, while the joints of the whole interior face of the old foundation were raked out to a depth of about 15 centimetres and pointed with cement mortar; this was done to prevent settlement from any washing of the mud out of the joints westward.

The trench, formed by the junction of the different shafts when the work of underpinning was completed, was afterwards filled in with stones and earth, well flooded with water and allowed to settle, the filling stopping about 50 centimetres short of the pavement-level. After the filling had thoroughly settled and hardened, a new pavement 50 centimetres thick, made of broken lintels which formerly encumbered the colonnade court, was laid down (*see* page 18).

THE GREAT TEMPLE OF ISIS.

(*Plate V.*)

At the Great Temple of Isis the bed-rock comes to the surface at the second pylon and on the east side of the interior of the hall of columns. In addition, it was found in 1896 that the walls of the temple descended to rock at the levels of 101·8 to 100·2 metres. Hence this temple required no underpinning operations, and the only work done in it was the filling of the crypts with rubble masonry in 5 to 1 Portland cement, to prevent accumulation of stagnant water.

THE EASTERN ANNEXE OF THE TEMPLE OF ISIS.

(*Plate X.*)

Under the heading of "Eastern Annexe" are included all the buildings on the east side of the forecourt of the Great Temple of Isis, viz., the colonnade, the library, the laboratory for preparation of incense, and other priests' rooms, the passage of Tiberius and the doorways adjoining it.

The exploratory works showed that here, as at the Mammiseum, the rock-level falls very rapidly southward from about 102 metres near the second pylon to about 95·5 metres near the first pylon. The colonnade and smaller rooms rest on a continuous pavement of stones 50 centimetres thick, the base of which is at 103·3 metres, or about 15 metres below the surface. This pavement does not continue under the passage of Tiberius; the side walls of the latter have, however, their base at the same level as the base of the pavement. The doorway at the east side of the passage, opening into the Coptic street, is a quite distinct structure from the remainder of the mass, and its base only descends to 104·25 metres, *i.e.* to the level of the street-paving.

The whole, with the exception of three of the intermediate transverse walls, which are carried on steel girders surrounded with masonry to a depth of 1½ metres, has been underpinned with rubble masonry, in 3 to 1 Portland cement, down to 97 metres, or to rock where the rock-level is above this level. The thickness of the masonry walls put in under the colonnade is 1·5 metres, that under most of the other walls 1·20 metres, while under the doorways it is carried the entire width of the old foundations. The new masonry under the east doorway extends, in consequence of the shallowness of the original foundations, to a greater thickness than at any other point of the island, being in fact 7·25 metres deep.

The colonnade, from the great pylon as far as column No. 9, was treated separately from the rest of the building, the excavation being made in the forecourt.

The passage of Tiberius and the doorways at either end of it were excavated mainly from within, while the south doorways and the smaller rooms were all done from the east side. The excavation under the south doorway exposed the base of the second pylon, which is on rock, the stones being cut so as to fit over the undressed rounded granite masses; as the pylon is on rock, the underpinning was carried butt up to its foundation.

TEMPLE OF ISIS USRET (THE MAMMISEUM).

(*Plate XI.*)

The original portion of this temple consisted of only two rooms; at a later date a further room was added at the north end, and the whole was surrounded by a colonnade, with a hall of two columns at the south end, where the main entrance is. Conspicuous open joints, due to differential settlement, mark the junctions between the work of the different periods. The foundations of the primitive and added portions are distinct, but generally approach each other closely.

The depths of the various footings differ considerably, but they descend on an average to the level of 101·5 metres, *i.e.* 3 metres below the surface. The rock-level falls from about 95·5 metres under the north-west corner to 91 metres under the south-eastern one.

It was decided to underpin both the interior structure and the surrounding colonnade with a rubble masonry wall in cement, of a sufficient width (4 metres) to take both the outer and inner old foundations, carried down to 97 metres, or to rock where this was struck before reaching 97 metres.

The two columns in the hall at the south end were likewise underpinned to this depth, the masonry under them being bonded into that under the adjacent walls. The two intermediate cross-walls were underpinned each with a pair of 14 inch by 6 inch steel girders, placed 75 centimetres apart.

TEMPLE OF HATHOR.

(*Plate XII.*)

The explorations showed that the forecourt columns rest on footings 1·5 metres deep, while the foundations of the standing chamber are slightly deeper, descending to 103·2 metres, or about 1·8 metres below ground. The width of the base in each case is about 1·25 to 1·5 metres. The rock was struck under the north-west corner of the forecourt and outside the quay wall at 95·7 and 95·4 metres respectively.

As the forecourt, which is in a very dilapidated condition, was not touched, but it was advisable to underpin the foundations of the small adjoining chamber to saturation-level by a cell of rubble masonry in cement, the walls being 1·40 metres thick. With the exception of the south end, which was got at from the outside, the whole excavation was done from the interior of the chamber, which was unpaved. It was found that the ancient builders had first got out a vertical-sided rectangular excavation, some 4 metres deep, of the size of the structure, and in this had placed a bed 2 metres thick, of large, closely-packed granite stones to serve as a rubble basis for the masonry proper. These irregular stones had to be taken out during the excavation for underpinning.

HADRIAN'S GATEWAY.

(*Plate XII.*)

The old foundations of Hadrian's Gateway and the adjoining Chapel of Osiris are of some complexity; the gateway is a distinct superstructure from the adjoining passage-like chapel, but both appear to be built on the foundations of older structures. The foundations under the greater part of the gateway descend at least to 99 metres, and those of the north wall of the chapel rest on silt at 101·35 metres, while the south wall foundation extends only to 102·2 metres.

As the difference of level of the foundations on the two sides might have given rise by differential settlement, to collapse of the walls, the south wall was underpinned to the level of the base of the north one, *i.e.* to 101·35 metres, the new masonry being carried northward so as to join on to the existing work and form a continuous base right across the width of the Chapel.

GATEWAY OF PHILADELPHUS.

(*Plate V.*)

The foundation of this gateway was found to extend down to 102·7 metres, and to be continuous across the opening. As the base of the adjoining great pylon is at 100·9 metres, some 1·8 metres lower, differential settlement was to be anticipated, and to prevent this the foundation of the gateway was underpinned with rubble masonry in cement down to the level of the pylon base. It was found that the ancient builders had got out a vertical-sided open excavation about 2 metres deep, of the exact size of the proposed foundation, in which they had placed a bed 75 centimetres thick of clean dry river sand as a basis for their masonry. When the foundations of the pylon adjoining the gateway were exposed, it was seen that instead of being continuous past the latter, the two lower courses were omitted where they would have come alongside the gateway. The explanation would appear to be that (as the pylon is of later date than the gateway) in getting out the pylon foundation, the sand under the gateway was tapped, and the builders feared to go any deeper at this point lest the gateway should fall.

THE TEMPLE OF TRAJAN, COMMONLY CALLED "THE KIOSK" OR "PHARAOH'S BED."

(*Plates XIII and XIV.*)

The exploratory works had shown that this temple was founded on broad footings descending about 4 metres below the surface, while the rock-surface falls from the level of 95 metres at the north-west corner to below 90 metres at the east side. It had also been found that longitudinal walls existed within the building near the east doorway, but the true extent and significance of the substructure only became evident after a large portion of the excavations for underpinning down to saturation-level had been got out. It then became evident that the Kiosk, like the Temple of Nectanebo, was built over old foundations, but askew to them.

The underpinning consists of a rubble masonry wall in 3 to 1 Portland cement mortar, 4 metres thick, of which the centre line coincides with that of the columns, descending to the level of 97 metres, and only interrupted where (under the east wall) the existing foundations extend down to, or nearly to, this depth.

Some of the vertical joints of the south screen walls were already slightly open (in some cases 1 centimetre) before work was commenced; these doubtless represent an ancient slight settlement, but the timbering at this point was carried out with exceptional care and strength, and though the cracks were carefully watched, no increase was detected during excavation.

With the exception of a single shaft between the two columns in the entrance-hall, the whole of the excavation was done from the outside of the building, so as to avoid breaking through the paving which exists in parts.

In 1901, the ruins of the Coptic village, which, since 1896, had been left for scholars to study, were in part cleared away in order to remove the principal source of the salt, the presence of which had caused considerable damage to the temple walls near the ground-level. The rest of the village was removed in 1902, previous to the first filling of the Reservoir.

Present Condition of the Buildings.

The condition of the temples on the Island of Philæ when the Reservoir was first filled at the end of 1902 may be described as follows. The extensive masonry works which had been carried out rested on the granite rock or upon sand which was permanently saturated, so that no change in its physical condition could take place by the rise and fall of the water in the Reservoir; the temples and other structures stand on rock, or on permanently saturated Nile sand and mud, or on masonry carried down to such permanently saturated material.

The water level slowly fluctuates from the level of 97 metres above sea-level to 106 metres above sea-level, and will in five years' time rise annually to 113 metres above sea-level. At all seasons, the parts of the buildings which are above water level are exposed to an extremely dry atmosphere in which the relative humidity at 2 p.m. ranges from 8 per cent to 56 per cent,* while the temperature in shade rises to 42° C.,† and that of the surface of the sandstone blocks may easily reach 70° or 80° C.; evaporation, therefore, is rapid at all seasons.

The stone is very porous and water rises very rapidly between the grains by capillary attraction, evaporating at the surface of the blocks, so that the salts which were previously in solution crystallize out at the surface between the grains or in any crack or joint which may exist.

The rubbish from the Coptic village had been cleared away, and with it the salts which had accumulated in it from the decomposition of organic matter; some of these salts had entered into the face of the porous sandstone of which the temples were built during the many centuries that the village ruins had lain heaped against their walls. Stones which had much deteriorated have been replaced, but it was inevitable that an excess of such salts should have accumulated in the surface layer of the lower courses of the buildings, to appear as an unsightly efflorescence when the stone was alternately wetted and dried.

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* Monthly mean values; extremes are 2% and 79%.

† Mean maximum temperature; absolute maximum is 47° C.

During the past five years the island has been annually submerged, and the reports which have been published from time to time show that at first there was a considerable amount of salt efflorescence on the walls and that the greater part of the ground between the various buildings was covered with a thin layer of efflorescent salts consisting of chlorides, sulphates, and nitrates. The efflorescence on the walls is noted as becoming much less in subsequent years, and, as the salt on the ground is not mentioned after the summer following the first filling of the Reservoir, it presumably did not again occur; at the present time, there is practically none visible. Efflorescence only occurs above the highest level of the water, so that the salts in the soil of the island, and in the sandstone itself, have been in part washed out, and in part carried higher up.

When the Reservoir is full each year, algæ grow on the faces of the walls, and die when the water falls; but only within thirty centimetres of the surface are they numerous, and here form a white band of dead and bleached algæ which some observers have taken to be a line of efflorescent salts; below this the remains of those which exist in greatly diminished numbers have imparted a greyish colour to the stone. It has been the practice to remove the algæ and the salt efflorescence annually by scrubbing with brushes, but this must also remove any sandgrains from the face of the stone which have been already loosened by the crystallization of the salts.

The published reports make no mention of settlement of any of the walls, though in two instances a slight opening of pavement joints is mentioned. These favourable reports have probably reached but a small number of readers, but on the other hand statements have been made to the effect that the stone employed in the construction of the temples must inevitably soften in the water, and that it is already losing its power of resistance; such opinions have doubtless been advanced by those who have not had all the facts before them, for it is difficult to see what valid evidence supported this conjecture, many facts being directly opposed to it. All the stone in foundations, whether permanently or periodically wetted by the flood, was found in 1896 and 1901 to be perfectly sound, and the quay walls, which have been submerged annually for twenty centuries and more, show no deterioration, but, on the contrary, contain some of the soundest stone to be found on the Island. There is, therefore, good reason for believing that submersion itself does no harm to the stone where the latter has been unaffected by accumulations of salt-bearing mud-brick rubbish, and that even where it has been so affected submersion rids the stone of the damaging salts; above the village rubbish, the salt existing naturally in the sandstone has caused a certain discoloration, but one or two years' submersion appears to remove it. The action of the salt naturally present in the sandstone is, when water reaches the stone, to disintegrate the surface to a small extent above the maximum water-level, but this is not in any way commensurate with the extent to which the same action takes place in the lower courses of every temple in the country from the soil-moisture facilitating the crystallization of the salts which exist in the stone or are supplied to it from the neighbouring soil. These questions will be dealt with in detail below.

EXAMINATION MADE IN NOVEMBER, 1907.

In October, 1907, the Ministry of Public Works appointed the present Committee to report upon the structural stability of the temples; to study the salt efflorescence and the discolouration of the walls; to determine its cause, and to endeavour to find a means of preventing its occurrence, or mitigating its effect; and to collect all information bearing upon the durability of the sandstone of which the buildings are constructed. The information thus obtained should assist in deciding what steps could most profitably be taken for the preservation of the buildings when more deeply submerged, as well as of other ancient temples and structures in Nubia which are likely to be affected by the Reservoir when enlarged.

The results of this investigation, so far as they are available, and the conclusions which have been drawn from them, are given in this report, but certain other experiments require a considerable time for their completion, and should be carried out in the course of the next two or three years.

For the study of the temples themselves, the photographs and plans made in 1895–1896 were used, as well as the plans of the underpinning and of the other consolidation works which were carried out in 1902, and also the three reports published by M. Maspero, which have already been quoted.

A detailed examination of the buildings showed that there was no evidence of their stability having been, in any way, affected, or that any one of them had moved since the underpinning operations of 1902; certain points to which attention may be drawn were, however, noticed. A comparison between the condition of the Temple of Nectanebo in 1895 and its present condition showed that no change had taken place, except in the position of the three top courses of the northernmost column but one on the east face; these courses had been displaced, probably by a blow from a boat, which had apparently collided with the wall of the temple when the island was inundated. The effects of a similar blow are noticeable in the wall between the south-west corner of the quay-wall and this temple; the second and third courses above the windowsill (south wall) have here been displaced to the extent of about five millimetres.

It is noticeable that certain unimportant settlements have occurred where no underpinning was carried out, and attention may be drawn to the following examples:—

(1) A settlement of the steps leading to the northern doorway of the Temple of Nectanebo. This is shown by a crack from east to west across the pavement;

(2) A settlement of the pavement on each side of the colonnade which lies across the steps enclosed between the western quay-wall and the west wall of the Temple of Nectanebo;

(3) A settlement of the paving of the western colonnade, where it is unsupported by the masonry; (*see* page 12).

(4) A settlement of the steps leading to the doorway in the west wall of the Temple of Isis;

(5) A settlement of the pavement inside Hadrian's Gateway, as reported by Mr. A. Weigall in June, 1905.*

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* *Annales du Service des antiquités de l'Egypte*, Tome VII, p. 73. Le Caire, 1906.

All these settlements are due to the compacting of the soil which forms the bed on which the steps or pavements lie. In most cases, the soil had been taken out during the underpinning operations, and, though well rammed when replaced, a small reduction in bulk has since occurred. Such settlements are, however, unimportant, as, of course, they cannot affect the stability of the buildings, being confined to the filling between the masonry. The hair-cracks noticeable in the cement pointing between the lintels of the east and west colonnades may have been regarded as indications of settlement having taken place in the underpinning, but there is no proof of this, and all the evidence tends to show that no movement has occurred; similar cracks in the cement occur in positions where settlement is out of the question, as, for example, in the northern wall of the great Temple of Isis. Such cracks therefore are to be attributed more probably to the material and workmanship employed in pointing the joints, rather than to any settlement.

The cement pointing is a failure to a great extent, for a large portion of it has cracked or fallen out. The failure of the pointing was touched upon in Mr Weigall's report of 1905, and its condition is very noticeable in the external walls of the Temple of Isis Usret. It is a question whether pointing does not do more harm than good, by preventing the salts from working out through the joints, where less harm would be done by crystallization than upon the surface of the blocks; it is certain that it neither adds to the solidity of the structure nor prevents water from gaining access to the interior of the stone, since a block becomes fully saturated in the course of a week's submersion.

No noticeable settlement, such as might have been expected, has occurred between the underpinned part of the Temple of Hathor and the forecourt which has not been underpinned. It is possible that some slight settlement of some of the blocks in the south wall of the forecourt may have occurred, but the evidence of this is indefinite; if any movement has taken place, it has been small.

It is recommended that, before further submersion, the mud-brick of Coptic or Arab date which still remains on the top of the colonnades, upon the north and south sides of the chapel of Osiris and upon the top of the gateway between the first pylons, should be removed; and that means should be adopted for the protection of steel from rust where bars of this metal have been inserted to support blocks of stone. The chief danger in the future will probably be from boats. It would be well therefore to anchor booms, especially at the south end of the Island, to serve as a permanent protection to the buildings; and, finally, as the effect of submerging lintels or roof slabs is unknown, it is desirable to examine them from time to time, in order to determine whether their resistance is in any way affected by the periodic submersions to which they will be subjected under the new conditions; also to undertake experiments on slabs of sand stone from the Girtass quarries (whence the stone used on Philæ was obtained) in order to determine the resistance of the stone under the new conditions. Up to the present time none of the large roof blocks have been submerged.

In concluding this portion of the report, it may be confidently stated that, in consequence of the work which was done during 1902 in underpinning and consolidating the temples and other structures on Philæ Island, these buildings are now far more safely founded than they have ever been, except in the case of those which were originally built on the granite rock, and which therefore were never endangered; that after five submersions no damage from settlement has occurred, and there is no sign of any movement except in the case of a few steps and pavement slabs which are laid on loose filling, and even here the movement is slight and of no importance. There is no temple in the Nile Valley at the present time which is more secured against failure by settlement or by collapse under any conditions, short of a violent earthquake, than those now on Philæ Island.

There remains the question of deterioration of the material of which the buildings are constructed.

They are built exclusively of a sandstone of cretaceous age, known as the Nubian sandstone, which occurs over a very wide area of the deserts of Egypt and the Sudan, and through which the Nile in Nubia has excavated a great part of its valley. It varies considerably in texture and in lithological character from being a conglomerate at its base, where it rests on the eroded surface of the crystalline rocks, to a fine-grained sandstone containing a considerable amount of clayey material; in places it is white in colour, but a light yellowish-brown shade is more usual, and by staining by oxide of iron and manganese it may become a dark reddish-brown and even black in places. The darkest specimens occur as bands or patches in lighter rock. The stone has been quarried in ancient times at many places in the Nile Valley in order to provide a building material for temples, and the ease of working it, its even colour, and the absence of strongly marked bedding-planes made it particularly suitable. In come places clayey beds are considerably developed so as to divide the sandstone into thin beds, and at others the clays form beds of considerable thickness, but usually there is no difficulty in obtaining a large supply of stone of very similar appearance, and of fairly even quality.

It was very extensively quarried at Silsila, sixty-eight kilometres north of Aswan, for the buildings at Karnak and Thebes, and the quarries of Girtass, forty kilometres south of Aswan supplied most, if not all the stone used at Philæ. Specimens from both places have been examined both chemically and petrologically, and the results are given here in order that those who are interested in the subject of this report may form their own judgment in the matter.

The temples and buildings on the Island of Philæ are of the sandstone from the Girtass quarries, which is a rather coarse-grained stone, having a specific gravity of about 1·9, a resistance to crushing of about 170 kilograms per square centimetre, and a very high porosity, the weight of water absorbed being almost 11 per cent when calculated on the dry weight of the stone, though large deviations from this value are met with.

The amount of soluble salts contained naturally in the stone has varied in the samples tested from 0·03 per cent up to 0·22 per cent. The cement between the individual quartz grains is very small in amount, and is chiefly ferruginous in character, with some decomposing felspathic material.

Specimens of the rock have been tested from time to time for one purpose or another, and the results have been brought together in the following table :—

NUBIAN SANDSTONE.

Physical Properties.

Quarry.	Dry weight per cubic metre in kilogs.	Absorption of water in % of dry weight.	Crushing load in kilogs. per square centimetre.	Salts soluble in water.	Authority.
				%	
Silsila	1994	9·00	127	—	Capt. Lyons. Given in "Annales du Service des Antiquités." Tome II, Caire, 1901.
	1925	11·18	186	—	
	1948	10·49	217	—	
	1867	11·52	125	—	
Mean ...	1933	10·52	163	—	
Not given, but probably near Aswan... ...	1850	11·16	152	—	Prof. Hudson Beare, London. Given in "Flood Protection for Egypt". Ministry of Public Works, Cairo, 1894.
	1860	9·91	112	—	
	1890	10·32	202	—	
	1950	9·87	264	—	
Mean of 12 cubes ...	1880	10·31	183	—	
Silsila	—	10·8	—	—	Survey Department Laboratories.
Aswan	—	11·0	—	—	
Silsila	1784	—	125	—	
	1827	—	233	—	
	1827	—	161	—	
	2031	—	211	—	
	1967	—	280	—	
Mean ...	1887	10·9	192	—	
Girtass	—	—	175	0·22	Survey Department Laboratories.
	—	—	57	0·06	
	—	—	66	0·03	
	—	—	92	0·05	
	—	—	63	0·16	
	—	—	124	0·16	
	—	—	81	0·13	
Mean ...	—	—	64	0·12	
Loose stone lying on ground ; Island of Philæ	—	—	—	—	Survey Department Laboratories.
Mean of 12 cubes ...	—	—	56	—	
Silsila	—	—	—	0·18	Survey Department Laboratories.
	—	—	—	0·07	
	—	—	—	0·11	
	—	—	—	0·18	
	—	—	—	0·27	
	—	—	—	0·29	
	—	—	—	0·11	
	—	—	—	0·12	
	—	—	—	0·14	
	—	—	—	0·18	
Mean ...	—	—	—	0·17	

The number of specimens is not very large, but from the data at present available it would seem probable that the stone from Silsila offers on the whole a greater resistance to crushing than that of Girtass, while containing a slightly higher percentage of soluble salts. The cubes cut from stones which had lain for some eighteen centuries in the village rubbish of the Island offered a much lower resistance to crushing, a result which may be due to the stone taking up soluble salts which in crystallizing out in its interstices diminished the cohesion of the stone particles.

Twenty-two specimens of Nubian sandstone from different localities have been examined microscopically by Dr. W. F. Hume, Superintendent of the Geological Survey; nine of these were from the quarries at Silsila, three were taken from fragments in the Hypostyle Hall at Karnak, which had in all probability been quarried at Silsila; three were from Philæ; and seven were obtained from the quarries at Girtass which had supplied the blocks of stone, etc., for Philæ.

FROM SILSILA QUARRIES.

1. Quartz with some felspar; ferruginous matter surrounds the felspars; the quartz is outlined by slight kaolinization; a few highly refracting minerals are present.

2. Plentiful interstitial matter; globular quartz; microline felspar; quartz crystals very fractured and irregular; plagioclase and microline felspar buried in amorphous paste; suggests crushing; small yellow highly refracting crystals—? epidote.

3. Limonite patches; iron oxide plentiful; grey felspars; quartz outlined by ferruginous material; highly refractive mineral—? zircon.

4. Similar to No. 3 but finer grained; quartz outlined by ferruginous material, which may be attacked in weathering.

5. Less ferruginous than No. 4; more felspathic material than in the first four samples.

6. More highly quartzose than first five samples; iron plentiful; zircon; strong tendency of iron oxide to form concentric coats.

7. The iron oxides occur in lines and patches; a great deal of felspar cementing grains; calcite also occurs as a cementing material, as do iron oxides.

8. Quartz grains outlined by ferruginous cement; a good deal of altered felspar.

9. Very ferruginous, with calcium carbonate.

These characteristics may be summarized as follows :—

(*a*) The cementing material is in no case zeolitic

(*b*) Calcite occurs in two instances in the dark-banded varieties;

(*c*) There is no evidence of siliceous cement;

(*d*) Neither sulphide of iron nor mica were present in the slides examined;

(*e*) The cementing material appears to be ferruginous and decomposing felspathic material.

FROM PHILÆ.

10. Quartz grains very loosely set with a good deal of void space which would make the stone very porous; a good deal of dark ferruginous material; muscovite mica very abundant

between quartz grains; shows perfect cleavage and tends to fray out at the edges; the mica also tends to lie along the bedding planes; a few grains of zircon showing zoning; ferruginous decomposition products between grains.

11. Quartz grains larger than in No. 10; altered felspathic material present; slide shows no muscovite mica, but it is visible in the hand specimen along bedding planes; ferruginous material slight.

12. A little muscovite mica; very irregular quartz grains set in a very little kaolinized material.

FROM HYPOSTYLE HALL, KARNAK.

13. Very irregular grains with ferruginous cementing material; slightly decomposed microline present in small amount; quartz shows corrosion; whole stone shows tendency to break up.

14. Similar to No. 13; undecomposed felspar; ferruginous decomposition products widely distributed; mica and felspar, probably microline.

15. Quartz grains with ferruginous cementing material and undecomposed felspar grains.

FROM GIRTASS QUARRIES.

16. Very irregularly shaped grains which are not united by any visible cement except along certain irregular bands where it is of a clayey nature.

17. Grains angular and about half the size of that in No. 16; crystalline aggregate present; grains in isotropic clayey paste; quartz has been broken and cemented by paste; large zircon.

18. Angular grains similar to No. 17; absence of marked cement.

19. Grains very angular and elongated; very little cementing material; the dark scattered masses in slide more ferruginous than felspathic.

20. Very irregular angular grains, many elongated; cementing material very little; scattered ferruginous enclosures.

21. More finely grained; a very finely granular paste is present as cement.

22. Differs from preceding; grains closely set in cement; cement decidedly ferruginous.

SUMMARY.

Nos. 16, 18, 19, and 20	Angular grains, poor cement, except bands in No. 16.
Nos. 17 and 21	Small angular grains, clayey cement.
No. 22	Large angular grains, ferruginous cement.

Though only a small number of specimens have been examined, they indicate that the sandstone of Girtass is somewhat inferior in cementing material to that of Silsila, which agrees with the higher resistance to crushing offered by the latter rock.

In the following table are given a number of analyses of samples of Nubian sandstone from Karnak Temple, the Silsila quarries, and from Philæ.

NUBIAN SANDSTONE.

Chemical Composition.

(Analyses made in Survey Department Laboratories).

Ingredient.	1	2	3	4	5	6	7	8	9	10	11	12
	%	%	%	%	%	%	%	%	%	%	%	%
Moisture and matter volatile at 100 C°	6·62	3·00	1·49	6·68	0·85	—	1·92	1·59	2·95	0·03	0·06	0·06
Combined water, carbon dioxide and organic matter	1·47	0·89	3·33	8·52	0·02	1·84	2·81	3·08	2·93	0·35	0·88	0·91
Silica and insoluble silicates ...	88·62	93·90	90·10	33·98	97·26	85·44	85·90	90·69	87·50	98·91	95·31	96·57
Oxide of Iron											0·34	0·49
Alumina	2·88	1·76	5·20	45·68	0·56	3·16	2·01	1·44	1·00	0·68	1·71	1·03
Oxide of manganese											—	—
Lime...	trace	0·52	0·36	4·70	0·44	0·52	2·25	1·02	0·96	trace	0·41	0·38
Magnesia...	trace	trace	trace	trace	trace	0·34	0·82	0·72	1·06	trace	0·09	0·19
Potash	—	—	—	—	—	trace	—	—	—	—	0·45	0·19
Soda	—	—	—	—	—	3·83	—	—	—	—	0·26	0·09
Chlorine	—	—	—	—	—	2·50	—	—	—	—	0·07	trace
Sodium chloride	trace	trace	trace	trace	11·10	—	2·65	1·46	3·60	trace	—	—
Nitric anhydride	—	—	—	—	—	—	—	—	—	—	0·36	nil
Phosphoric anhydride...	—	—	—	—	—	—	—	—	—	—	trace	trace
Sulphuric anhydride	trace	trace	trace	0·39	trace	1·58	1·64	nil	nil	nil	0·06	0·09
Carbon dioxide	—	—	—	—	—	—	—	—	—	—	nil	nil
Organic matter	—	—	—	—	—	—	—	—	—	—	trace	trace
Totals...	99·59	100·07	100·48	99·95	100·23	99·21	100·00	100·00	100·00	99·97	100·00	100·00

Nos. 1 to 9 inclusive .. .. Samples from columns in Hypostyle Hall, Karnak.
No. 10 .. .. „ „ Silsila quarries.
Nos. 11 and 12 .. .. „ „ Philæ Island.

The stone, then, which has been used in the construction of the temples, and on which the inscriptions and figures have been carved, is a moderately fine-grained sandstone of no great hardness or strength, the grains of quartz which constitute it being but lightly cemented together; very porous; having oxides of iron and manganese in spots and veins which produce discoloration; and containing a small percentage of soluble salts. The salts originally present in the stone are chiefly chlorides and sulphates, the chlorides largely preponderating; they are in no way corrosive, and if the stone remains dry no injury whatever can take place and no additional salts can gain access. If the stone be entirely submerged the same result holds good, any solvent action exerted by the water, even though aided by the salts present, is so small as to be inappreciable and quite negligible from a practical standpoint.

If, on the other hand, the stone is wetted and then allowed to dry or partially dry again, the salts are dissolved in the water, and by capillary attraction are brought to the surface, where they crystallize out as the water evaporates. This crystallization takes place not only on the outside of the stone, but also between and underneath the individual particles forming the surface layers, and the force of crystallization separate the particles and may eventually disintegrate the stone, especially if the cementing material is weak. When, as in the lower courses of the walls and the bases of the columns at Philæ, additional salts in comparatively large amount have gained access from the soil, this disintegration of the surface layers of the stone is considerably increased. When a building is partially submerged for some months at a time, the salts are entirely washed out from that portion under water, but accumulate just above high-water mark, there injuring the stone, and if there are inscriptions on this particular portion of the walls the injury becomes more evident. The damage done is also rendered more visible by the fact that in the region where the salts accumulate the stones never dry between two successive wettings on account of the great affinity the salts have for water. That the action is purely mechanical and in no way a chemically corrosive one was well brought out by some experiments made in Egypt several years ago,* and is confirmed by the conclusions arrived at by Dr. Borchardt † as the results of his investigations into the nature and cause of the disintegration that has taken place in the Philæ temples. Samples of the efflorescent salts from Philæ have been examined in the laboratories of the Survey Department, and included:—

13 samples of efflorescent salt from the walls,
4 samples of efflorescent salt from the ground,
14 miscellaneous samples;

these last include mud which was adhering to the walls, brown and black patches on the walls, algæ growths on the walls, and cement mortar which has been recently used in pointing the joints.

The efflorescent salts, whether on the walls or on the soil of the island, may be either essentially sodium chloride or essentially sodium sulphate, but generally consist of a mixture of both, together with small quantities of potassium nitrate and in a few cases a trace of sodium carbonate.

The brown and black patches on the walls contain both iron and manganese compounds in varying proportions.

Most of the samples were examined qualitatively only, as any quantitative analysis of the efflorescences would have been useless, since the percentage composition of each specimen taken would vary with the amount of the sample scraped off the walls.

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* *The Disintegration of Building Stones in Egypt*, A. Lucas. Cairo: 1902.

† *Bericht über die Corrosion des Sandsteinmaterials der Tempelbauten auf Philae*, Dr. L. Borchardt. Sitzungsberichte der Königl. Preuss. Akademie der Wissenschaften zu Berlin. XXIII, 1898.

The details as actually determined, however, are as follows :—

SAMPLE.	COMPOSITION.
Efflorescence, Colonnades	Sodium chloride.
” ”	” ”
” ”	Sodium chloride, sodium carbonate, sodium sulphate, potassium nitrate (chiefly sodium chloride.)
” ”	Sodium chloride, sodium carbonate, sodium sulphate, potassium nitrate (chiefly sodium sulphate).
Damp mud	Sodium chloride, sodium sulphate, and potassium nitrate.
”	” ” ” ” ” ” ”
Efflorescence — Soil of Island ...	Sodium chloride, sodium sulphate, and potassium nitrate (chiefly sodium sulphate).
” ”	Sodium chloride, sodium sulphate, and potassium nitrate (chiefly sodium chloride).
” Great Pylon	Sodium chloride, sodium sulphate, sodium carbonate, potassium nitrate (chiefly sodium chloride).
Decayed stone, Temple of Isis, North	Sodium sulphate, sodium chloride, potassium nitrate.
” ” ” ” East	” ” ” ” ” ”
Efflorescence ” ” East	” ” ” ” ” ” (chiefly sodium chloride).
Mud ” ” South	Consists of dry Nile mud and dirt.
Efflorescence, ground, south of Island	Sodium sulphate, sodium chloride, potassium nitrate (chiefly sodium sulphate).
Decayed stone, Temple of Isis North	Sodium chloride, sodium sulphate, potassium nitrate.
Efflorescence, inside Kiosk	Sodium chloride, sodium sulphate, potassium nitrate (chiefly sodium chloride).
” ”	Sodium chloride, sodium sulphate, potassium nitrate, (chiefly sodium chloride).
Brown patch, East Colonnade outside	Containing iron and trace of manganese.
Black patch, East Colonnade inside	” ” ” manganese.
Blackening — on old stones	” ” ” ”
” Kiosk.	Chiefly manganese, trace of iron.
” ”	” ” little iron.
Soil, south of Island	Contains 0·34% soluble salts; trace of sodium chloride and sodium sulphate.
” north ”	Contains 0·34% soluble salts; trace of sodium chloride and sodium sulphate.
Cement mortar; roof Temple Isis...	per cent. Sand and insoluble silicates ... ... 50·70 Soluble silica ... ... 8·70 Oxide of iron and alumina ... ... 1·40 Lime... ... ... 23·00 Magnesia ... ... 0·49 Sulphuric anhydride ... ... 0·61 Loss on ignition, being water and carbon dioxide ... ... 9·20 Not determined.. ... ... 5·90 100·00
Cement mortar; East Temple of Isi	Composition similar to above.
” ” roof ” ”	” ” ”
” ” on town gateway...	” ” ”
” ” courtyard below pylons...	” ” ”
Stones with algæ	The coating on the stones consists of filamentous algæ.

As it has been suggested that the river water is capable of rendering the sandstone soft and incoherent, a series of analyses of Nile water are given, though the absurdity of this view will be evident to anyone who knows the stairways and quay-walls of the ancient temples which have always been washed for many centuries by the Nile.

YEARLY SUMMARY — RIVER WATER.

SAMPLES TAKEN WEEKLY AT GIZA.

(Milligrammes per litre).

1905.

Month.	Total Solids.	Chlorine.	Sodium chloride.	Free ammonia.	Albumd ammonia.	Nitrites.	Nitrates as nitrogen.	Oxygen absorbed. *
January	170	6·7	11·0	0·019	0·385	trace	trace	3·00
February	193	9·6	15·9	0·020	0·353	trace	nil	2·71
March	207	14·7	24·3	0·018	0·298	trace	nil	3·27
April	230	20·1	33·2	0·023	0·281	nil	nil	2·55
May	240	24·3	40·1	0·036	0·391	trace	trace	2·39
June	230	23·7	39·2	0·063	0·590	trace	nil	2·91
July	206	20·5	33·8	0·035	0·850	trace	nil	4·02
August	180	12·2	20·2	0·063	0·888	trace	0·37	5·31
September	140	3·6	5·9	0·081	0·670	trace	0·52	15·21
October	132	3·7	6·0	0·041	0·982	nil	0·14	9·13
November	146	5·0	8·2	0·028	0·521	trace	0·08	5·08
December	150	6·8	11·3	0·041	0·423	trace	trace	2·92
Mean...	186	12·6	20·7	0·047	0·636	trace	0·09	4·87
Maximum	260	26·0	42·9	0·225	2·160	trace	0·07	20·70
Minimum	125	2·5	4·1	0·010	0·185	nil	nil	2·05

1906.

Month.	Total Solids.	Chlorine.	Sodium chloride.	Free ammonia.	Albumd ammonia.	Nitrites.	Nitrates as nitrogen.	Oxygen absorbed. *
January	157	7·6	12·5	0·031	0·315	trace	trace	2·90
February	163	11·0	18·1	0·021	0·338	trace	trace	3·30
March	182	14·0	23·1	0·024	0·325	nil	trace	2·79
April	211	19·2	31·6	0·023	0·408	trace	nil	2·40
May	215	19·9	32·8	0·041	0·342	trace	nil	2·75
June	217	20·1	33·1	0·030	0·407	trace	trace	3·22
July	215	19·4	32·0	0·001	0·488	trace	trace	3·71
August	170	9·2	15·2	0·749	0·802	trace	0·32	12·83
September	130	3·6	6·0	0·058	0·992	trace	0·23	14·25
October	130	3·7	6·9	0·026	0·618	trace	trace	7·42
November	140	4·6	7·6	0·023	0·407	trace	trace	5·02
December	133	5·2	8·8	0·010	0·289	trace	trace	3·17
Mean...	172	11·4	18·9	0·037	0·477	trace	0·046	5·31
Maximum	239	24·5	40·0	0·325	1·280	trace	0·60	21·02
Minimum	124	3·2	5·3	0·005	0·212	nil	nil	1·90

1907.

Month.	Total Solids.	Chlorine.	Sodium chloride.	Free ammonia.	Albumd ammonia.	Nitrites.	Nitrates as nitrogen.	Oxygen absorbed. *
January	150	6·6	10·9	0·008	0·232	trace	trace	2·82
February	149	8·5	14·1	0·011	0·299	trace	trace	3·06
March	170	11·5	19·0	0·022	0·307	trace	trace	2·90
April	208	18·3	30·2	0·010	0·291	trace	trace	2·62
May	217	18·4	30·4	0·013	0·299	trace	trace	2·55
June	231	20·0	33·0	0·016	0·401	trace	trace	2·71
July	207	17·4	28·7	0·138	0·746	trace	trace	4·21
August	172	10·1	16·7	0·015	0·656	trace	0·41	7·30
September	137	4·05	6·67	0·020	0·914	trace	0·39	12·50
October	127	3·8	6·3	0·009	0·565	trace	0·15	8·40
November	139	5·4	8·9	0·013	0·450	trace	0·10	4·44
December	145	7·6	12·5	0·042	0·386	trace	trace	2·83
Mean...	171	10·97	18·11	0·026	0·462	trace	0·087	4·69
Maximum	238	20·6	33·9	0·255	1·100	trace	0·62	12·90
Minimum	120	3·3	5·5	0·003	0·202	nil	nil	2·15

* In acid solution after boiling 10 minutes.

The free and albuminoid ammonia and the oxygen absorbed were determined on the samples as taken, but the total soluble matter, chlorides, nitrites, and nitrates after filtration through a Berkefeld filter.

RIVER WATER.

Results of Occasional Analyses.

Date.	Parts per million.				Parts per 100,000.	
					Hardness.	
	Manganese. Mn.	Iron. Fe.	Phosphoric acid. P_2O_5	Sulphur trioxide. SO_3	Temporary.	Permanent.
1904.						
January 31...	—	—	—	—	9·6	2·2
1907.						
April 1	—	—	—	13·1	—	nil
April 8	—	—	—	—	13·1	—
May 14	—	—	—	10·6	15·5	—
July 4	—	—	—	12·1	16·95	—
July 20	nil	0·20	—	—	—	—
July 27	nil	0·20	present	—	—	—
August 8...	—	—	—	8·6	15·7	—
August 10...	nil	0·25	3·0	—	—	—
August 17...	nil	0·20	—	—	—	—
August 31...	nil	0·25	3·0	—	—	—
September 7	nil	0·30	3·5	10·9	8·8	—
September 14	nil	—	—	—	—	—
September 21	nil	—	—	—	—	—

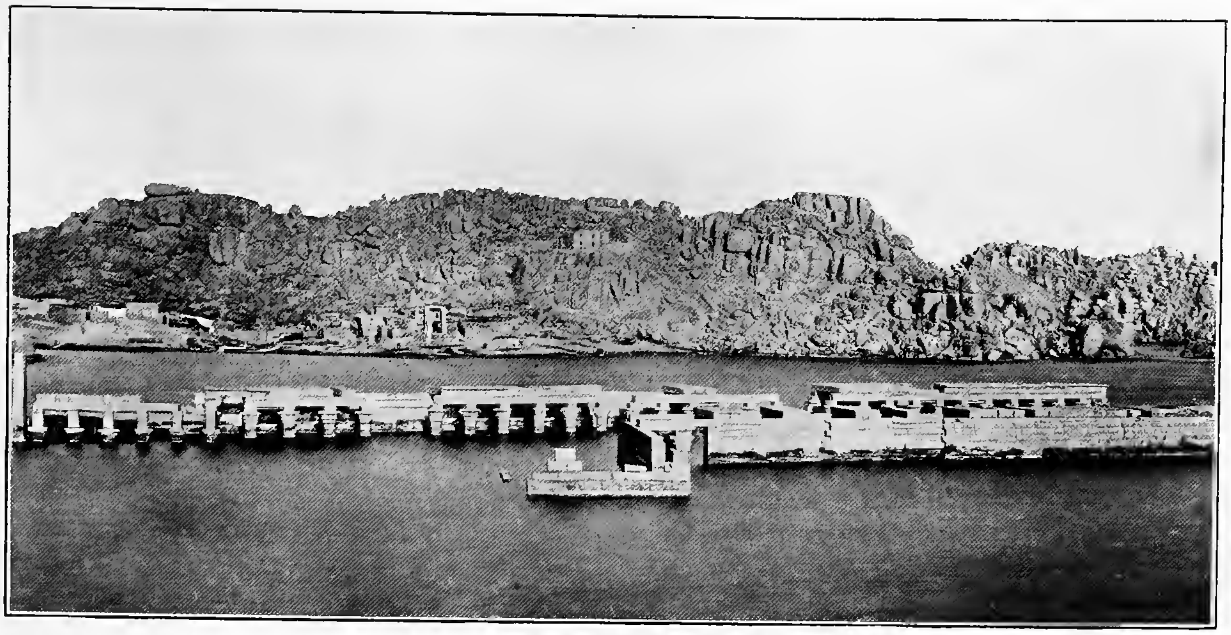
There has not been sufficient time to study the effect of different preservative solutions on the stone and to obtain results which would fairly represent the effect of their employment on an extended scale. The few data at present available from experiments made on specimens of Nubian sandstone are given here :—

PRESERVATIVE SOLUTIONS.

Solution.	Price per 100 square yards.	Appearance of stone after treatment.	Decrease of absorption.	Increase in crushing strength.	Resistance to "abrasion."	Composition.	Remarks.
	s. d.		%	%			
A	12 8	Considerably darkened ...	27·5	59	Good.	Glue and linseed oil.	Glue not permanent in water.
B	63 9	Darkened.	6 (Increase)	34·5	Fair.	Heavy petroleum in naphtha.	For preserving stone from acid fumes.
C	53 6	Practically unchanged... ...	12	4	Slight.	Xylonite in amyl acetate.	For preserving stone from acid fumes.
D	50 6	Colour unchanged...	1·5	41	Fairly good.	Sodium silicate and acid.	Probably no better than the cheaper sodium silicate and calcium chloride.
E	12 6	Slight efflorescence	—	—	—	Magnesium fluoride.	

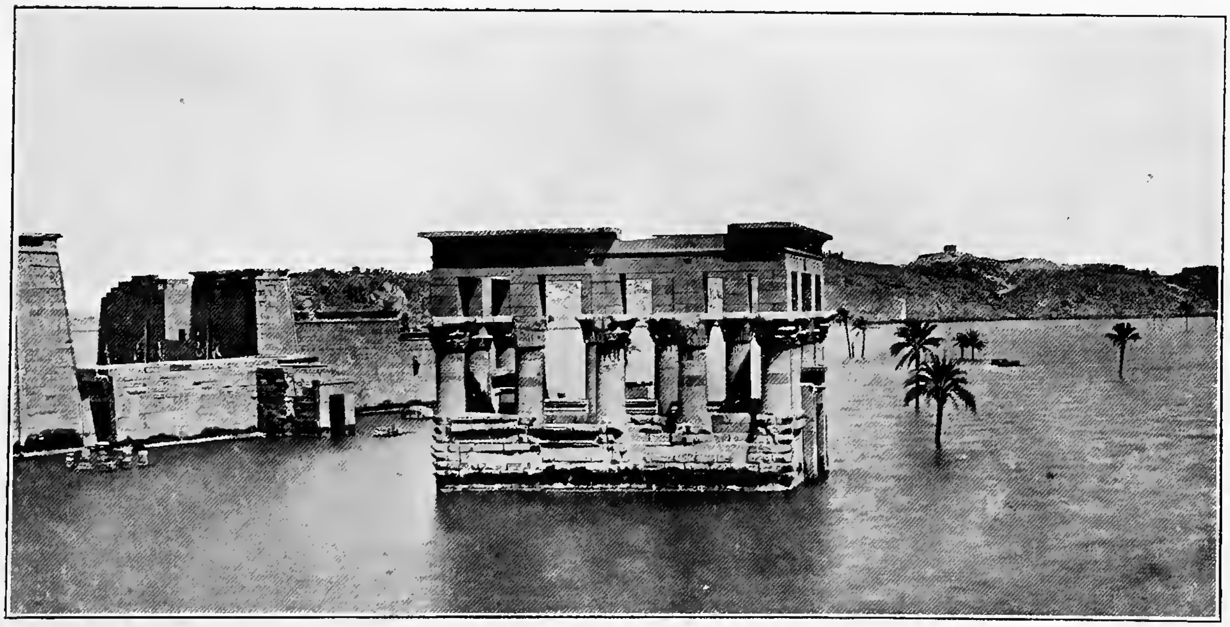
One of the most noticeable features of the river channel upstream of the dam is a very distinct white band, parallel to the water surface, that is present on all the rocks, and manifestly marks the height at which the water stands when the Reservoir is full. This band, which

PLATE II



The Colonnades from the east.

PLATE III.



Temple of Trajan (Pharaoh's Bed).

varies in width from 20 cm. to 40 cm., consists of the bleached remains of dead algæ. A similar white band occurs also at high-water mark on all the structures on Philæ, except inside various rooms into which little or no light penetrates, and where consequently the algæ, which require light, cannot grow. For about 3 or 3·5 metres below this white line the stones have lost their yellow-brown colour and have become grey in such places as the quay-walls and on the outside of the western colonnade. Where the stones have always been under water at high Nile the yellow-brown colour remains. The grey colour is purely superficial, and, like the white band above, is caused by algæ.

Above the highest limit of the algæ is a more disfiguring irregular zone of dampness accompanied by a white saline efflorescence (*see* Plates I–III). In places along the damp zone are patches, sometimes of a dark brown and sometimes of a purple-black colour. The former are due to oxide of iron, while the latter are in no way caused either by vegetable acids or by sulphide of iron, as has been suggested*, but are due to oxides of manganese. Both iron and manganese oxides are plentifully distributed over many of the stones that have not yet been touched by the water, and the mere fact of wetting causes these spots to become more distinct, and in addition there is probably a certain amount of solvent action whereby the iron and manganese compounds in the stones are dissolved out and brought to the surface by capillary attraction when the water recedes and there oxidized, thus intensifying the brown and black colours originally present.

In several places, as on the outer side of the wall at the north end of the Island, and at the south-west corner of the western colonnade, there is a black line consisting of the coal dust which collects on the surface of the water during the loading and unloading of coal on the opposite bank, and is eventually carried by the wind against the buildings on the Island.

Markings identical in every respect and due to the same cause were seen in Luxor Temple, where there were two black lines at different heights. In this case coal barges were unloaded on the river bank outside, and the dust collecting on the surface of the water, which at the time flooded the temple, blackened the stones at the water level.

There are six different discolorations on the walls of the temples at Philæ, namely :—

1. A white band about 30 cm. wide of dead and bleached algæ at high-water mark.
2. A broader belt of grey about 3 metres to 3·5 metres wide, also due to algæ, below the white band.
3. Dampness just above high-water mark.
4. White saline efflorescence accompanying the dampness.
5. Brown and purplish-black patches of iron and manganese oxides respectively in places within the damp zone.
6. A black line caused by coal dust and at present neither very marked nor very widely distributed.

Of these, four phenomena, Nos. 1, 2, 5, and 6, though disfiguring, are harmless, while Nos. 3 and 4 are not only unsightly, but injurious, and all the recent disintegration of the stonework is confined to the damage done by these two causes.

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* *Annales du Service des antiquités.* Tome V, pp. 254-255. Le Caire. 1904.

1 AND 2.—DEAD AND BLEACHED ALGÆ.

It is suggested that no attempt be made to remove the present white band, disfiguring though it be, since nothing short of very drastic scrubbing with hard brushes is likely to prove effective, and this treatment would probably injure the inscribed parts of the stones. The dead algæ are quite harmless, and the white colour will gradually disappear as the water level of the Reservoir is raised, giving place to the less marked grey colour of the belt below.

With regard to this grey colour, it would seem that nothing can be done, but experiments are in progress in order to ascertain whether a very weak solution of copper sulphate would prevent algæ from growing on the surface of the stone, without injuring or discolouring it. On the buildings which will be entirely submerged it will hardly be noticeable, since the whole of the walls will be of one uniform tint. But on those buildings only partially submerged the contrast between the yellow-brown colour of the stone above high-water mark and the grey colour below will be noticeable.

3.—DAMPNESS.

This is unsightly, but in itself harmless, the injury being done by the accompanying salts, which retain the moisture and prevent the stones drying as they would otherwise do. The lower courses, from which the salts have been washed out and which become much wetter, readily dry when the water falls. As the water in the Reservoir is raised, so the damp band will disappear, to reappear again just above the final high-water level. The only way of curing the dampness is to get rid of the salts.

4.—WHITE SALINE EFFLORESCENCE.

This efflorescence, in addition to being very ugly, is also causing injury to the surface of the stones, and this injury is more noticeable and of greater consequence where the stones are inscribed. As already explained, the salts present that give rise to the efflorescence are in no way corrosive, but simply act mechanically by crystallizing out between the individual quartz grains and underneath the surface layers, so disintegrating the stone. No attempt need be made, however, to remove the existing efflorescence, since it will entirely disappear from its present position as soon as the water rises, a part being carried away, and a part mounting to just above the final water-level. Any washing of that portion of the walls where the efflorescence appears is inadvisable. To thoroughly soak the whole of a salted stone in water is an excellent method of removing the salt, but to wash only a portion of a stone is only to remove the salt from one place to another, and generally to drive it inwards for it to reappear again later.

The buildings which up to the present have been submerged are free from salt. To submerge others in the future will be the best thing that could happen to them, since from these also the salt present in the sandstone will be washed out. Were it possible to submerge the whole of the buildings completely, the salts present in the stone might be removed and subsequent partial submersion would then cause no band of efflorescence and consequently no disintegration of the faces of the walls. In this connection it may be worth while referring to the fact already mentioned that the stones of the quay-walls which have been submerged annually for more than twenty centuries are among the best and soundest that remain ; there is nothing to show that they were specially selected in the first instance, indeed the same quarry marks occur on them and other blocks in many parts of the island.

5.—PATCHES OF IRON AND MANGANESE OXIDES.

Nothing can be done to remove the existing patches since they are inherent in the stone. In the future, however, when the salt mounts higher up the walls or is washed away entirely, the present patches will dry and so become less distinct, but unless the salt can be got rid of, other similar patches now existing, though not at present very marked, will become more distinct and unsightly.

6.—COAL DUST.

Under the existing arrangements for the handling of coal at Shellal, the temples of Philæ are always liable to a permanent disfigurement that may at any time be caused by coal dust settling on the practically stagnant water of the Reservoir and being driven by a north wind against the buildings, but with the increase in the level of the water this work will take place much further off and may not have the same effect.

In addition to the various points already mentioned, the following may be noted, namely :

(*a*) In places, more particularly in some of the inner chambers, there are dried patches of blackened mud and dirt adhering to the walls. This is not of recent origin, but evidently dates from the time before the chambers were cleaned from the rubbish that formerly filled them. This mud will doubtless gradually disappear.

(*b*) At the present time there are only very slight signs of any efflorescence of salts on the ground, hence the salts that were at one time so plentiful in the village rubbish on the Island have been almost entirely removed.

SUMMARY.

The following are the conclusions arrived at from the chemical evidence :—

1. Beyond the usual decay of old age brought about by atmospheric influences and water action, no special general destruction of the Philæ temples is taking place, except a local disintegration operating along the zone of almost a metre in width immediately above the high-water mark.

2. This local disintegration, which is purely physical and in no way a chemically corrosive action, and which is confined to the surface layers of the stones, is injuring the inscriptions in these places where it is taking place, by loosening the sand-grains.

3. This injury will cease at the present spots when the water level is raised, but will be transferred, though to a lessened extent, to fresh places just above any temporary high-water level, and will finally be localized above the maximum high-water mark attained, though by

this time the injurious salts will have considerably diminished in amount and thus any damage will take place to a less degree than is the case at present.

4. It may be possible, by thoroughly soaking the portions of the buildings which will remain unsubmerged at the time of highest water, or by the use of preservative solutions, that future damage may be avoided or considerably minimized, but this requires further investigation and experiment before it can be satisfactorily established.

5. Some discoloration of the temples just above high-water mark is inevitable, since nothing can prevent the formation of a zone of dampness above the water level, and this dampness, in addition to being itself unsightly, will render more prominent any existing patches of the iron and manganese oxides.

6. However, if the salts are eliminated, this disfigurement will only occur when the Reservoir is full, since the stones will dry rapidly as the water falls in the hot weather of June, July, and August.

CONCLUSIONS.

The conclusions which can be fairly drawn from the foregoing evidence are :—

1. The stability of the buildings which had been ensured by the underpinning executed in 1902 has now been placed beyond all doubt, since five submersions have caused no settlement of the masonry in any part.

2. A structural point which needs investigation is whether the roof-blocks of the temple chambers are strong enough to stand the strain of their weight and of any load which there may be on them in the shape of roof-paving blocks when both have taken up the additional 11 per cent by weight of water on submersion.

3. The river water alone has no appreciable action, either erosive or corrosive, upon the stone ; there is no appreciable current in the Reservoir after the water level has reached the buildings and wave action shows no sign, either on the quay walls or on the buildings, of being effective.

4. The salts in the soil of the island have been almost entirely removed, but the small percentage which the sandstone naturally contains remains wherever the stone-work has not been wholly submerged, together with the additional salts from the soil of the island which in the past have made their way into the stone.

5. These salts of the sandstone are the cause of such surface disintegration as is taking place, and also of the band of discoloration above the high-water level. Complete submersion would remove this destructive agent, and possibly pouring water on the unsubmerged portions might reduce it to insignificant proportions.

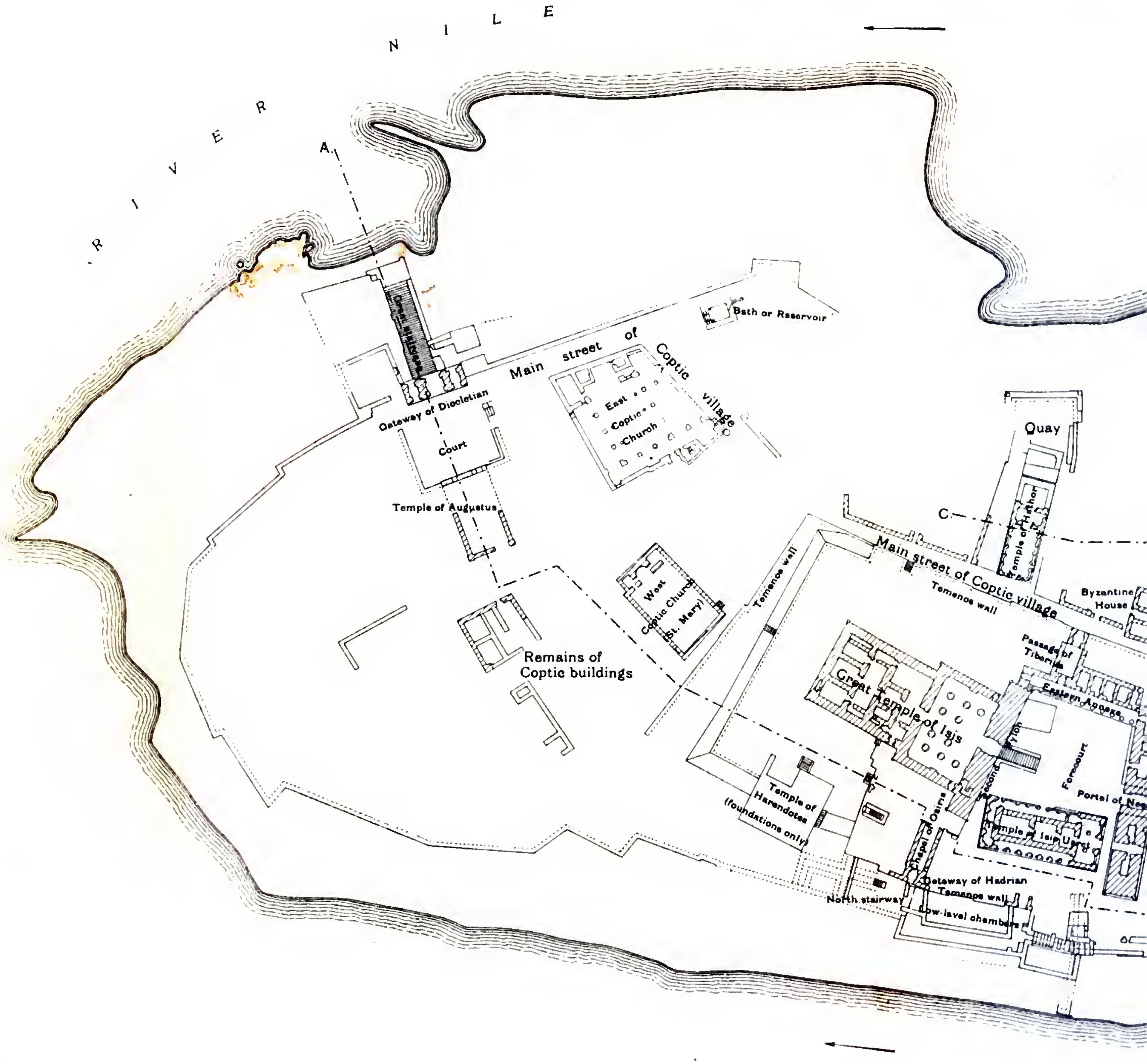
6. The grey discoloration of the submerged stone is due to minute filaments of dead algæ : these do no harm, but are not readily removable.

Cairo, February 29, 1908.

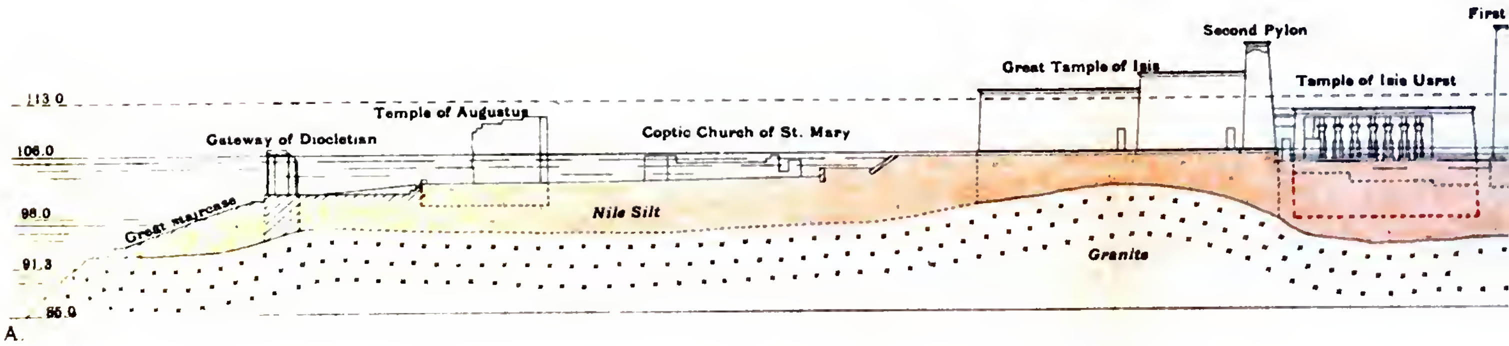
H. G. LYONS.

PHILÆ ISLAND.

GENERAL PLAN. (On completion of strengthenir



Longitudinal Section showing submersion of principal bu

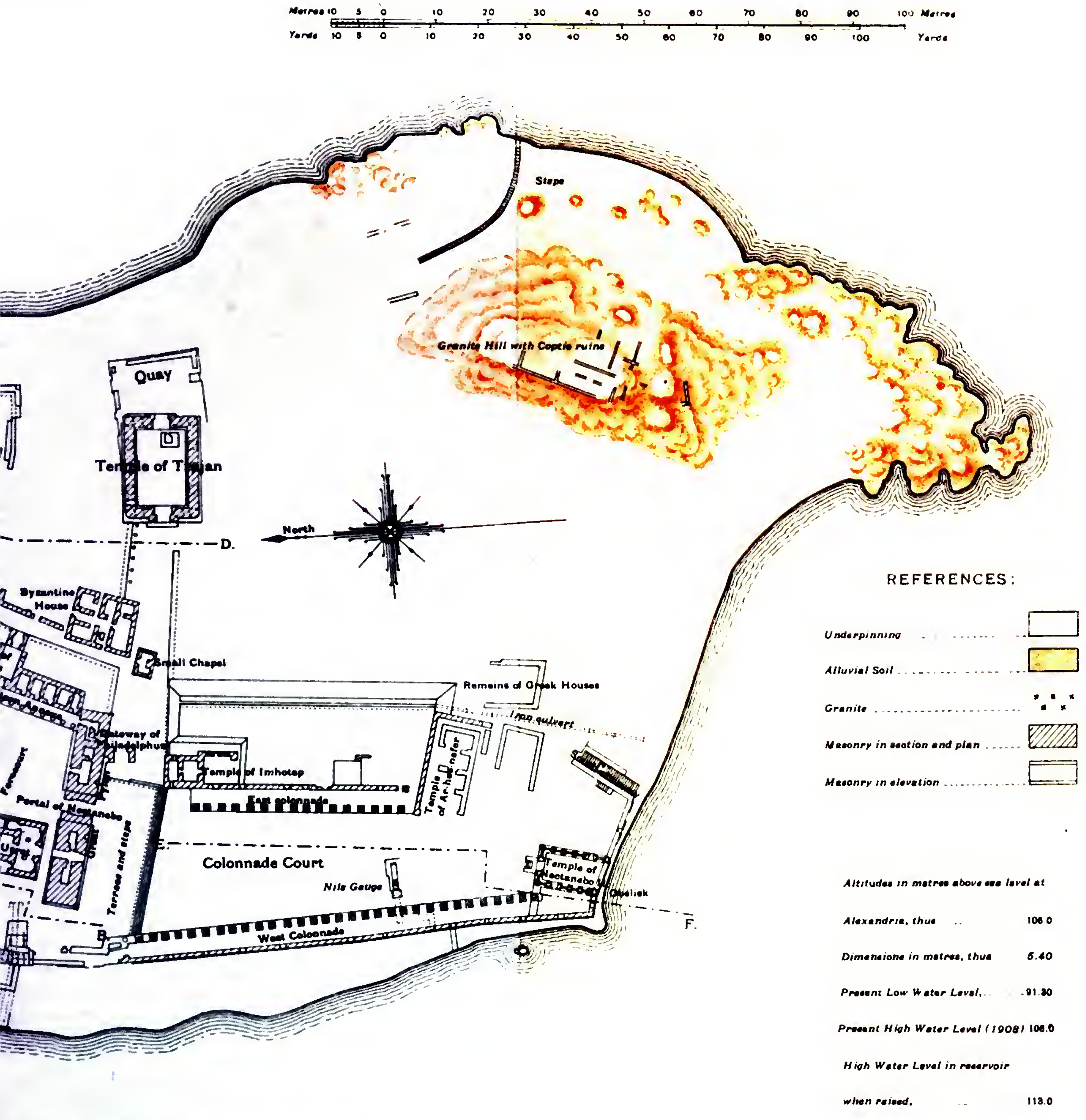


SURVEYED IN 1901

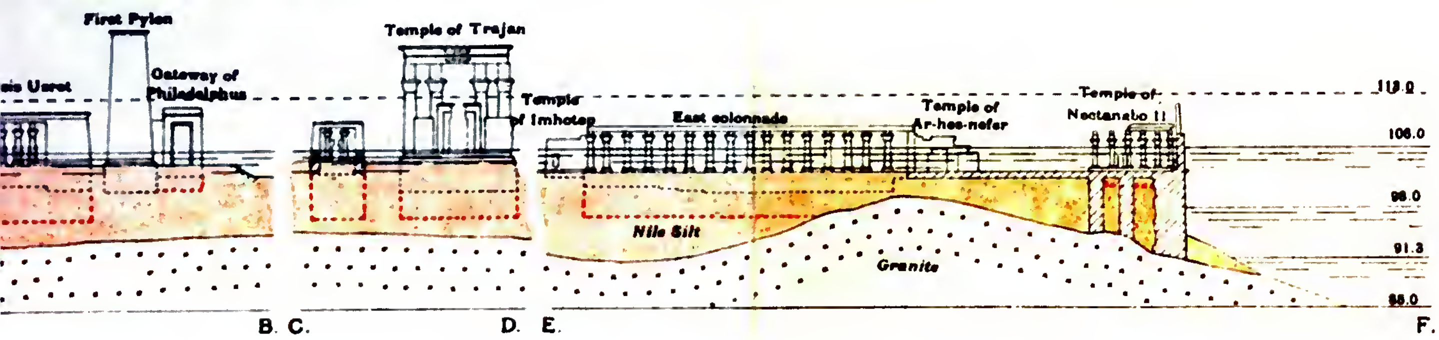
SURVEYED AND DRAWN BY DR J BALL

trengthening works June 1902.)

Scale 1 : 1,000

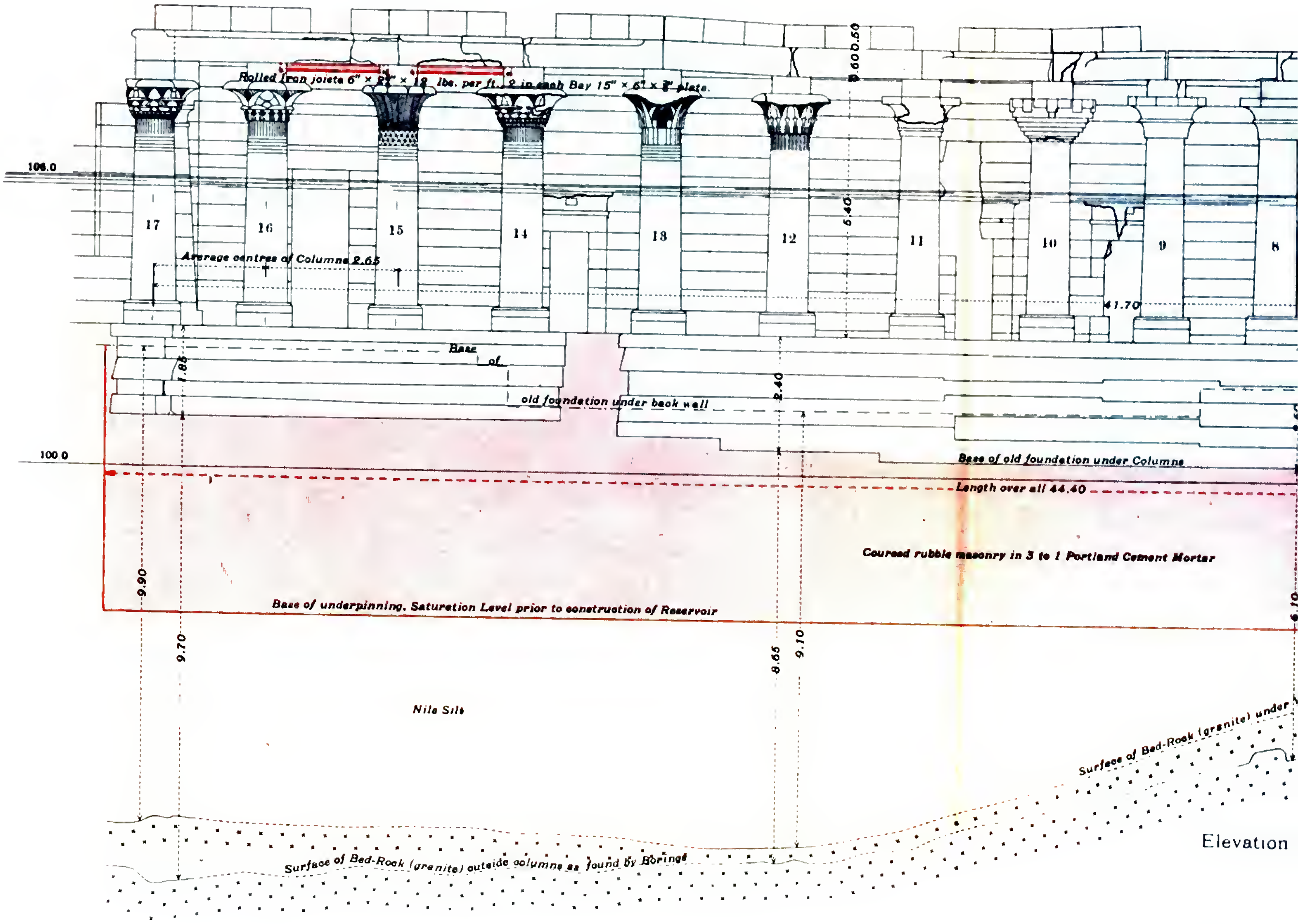

Metres 10 5 0 10 20 30 40 50 60 70 80 90 100 Metres
Yards 10 5 0 10 20 30 40 50 60 70 80 90 100 Yards
Steps
Granite Hill with Coptic ruins
Quay
Temple of Trajan
North
D.
Byzantine House
Small Chapel
Remains of Greek Houses
Iron culvert
Gateway of Philadelphus
Temple of Imhotep
Temple of Ar-hes-nefer
East colonnade
Forecourt
Portal of Nectanebo
Terrace and steps
E.
Colonnade Court
Nile Gauge
Temple of Nectanebo
Obelisk
F.
B.
West Colonnade
REFERENCES:
Underpinning
Alluvial Soil
Granite
Masonry in section and plan
Masonry in elevation
Altitudes in metres above sea level at Alexandria, thus 106.0
Dimensions in metres, thus 5.40
Present Low Water Level, 91.30
Present High Water Level (1908) 106.0
High Water Level in reservoir when raised, 113.0

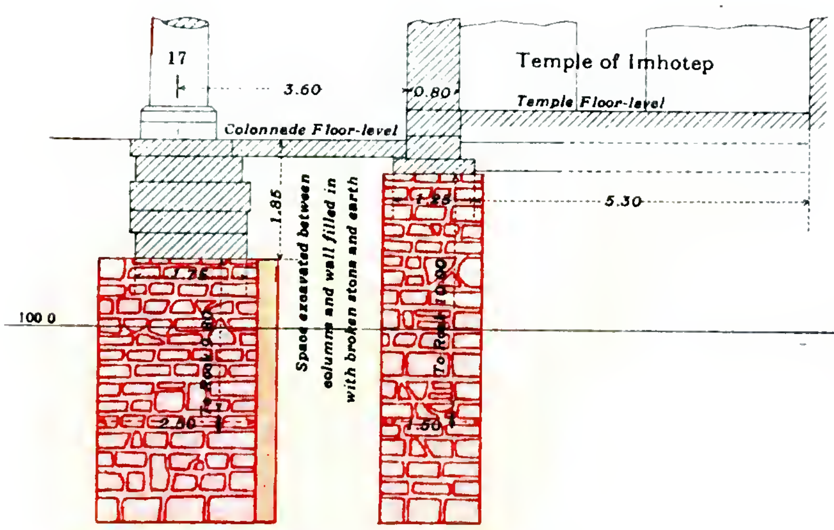
principal buildings when reservoir is filled to 106.0.



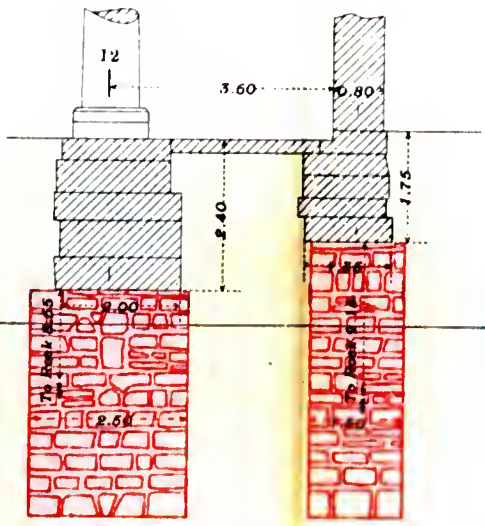
PHILÆ ISLAND.

EAST COLONNADE

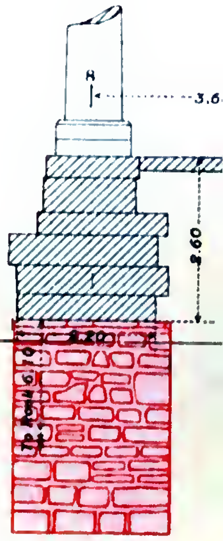

Rolled Iron joists 6" × 2½" × 12 lbs. per ft. 2 in each Bay 15" × 6" × ⅜" plate.
0.60
0.50
106.0
17
16
15
14
13
12
11
10
9
8
5.40
Average centres of Columns 2.65
41.70
Base of old foundation under back wall
1.85
2.40
100 0
Base of old foundation under Columns
Length over all 44.40
Coursed rubble masonry in 3 to 1 Portland Cement Mortar
9.90
Base of underpinning. Saturation Level prior to construction of Reservoir
6.10
9.70
8.65
9.10
Nile Silt
Surface of Bed-Rock (granite) under
Surface of Bed-Rock (granite) outside columns as found by Borings
Elevation



Cross Section near Extreme north Column.



Cross Section at No. 12 Column.



Cross Section at N

Scale 1 : 12

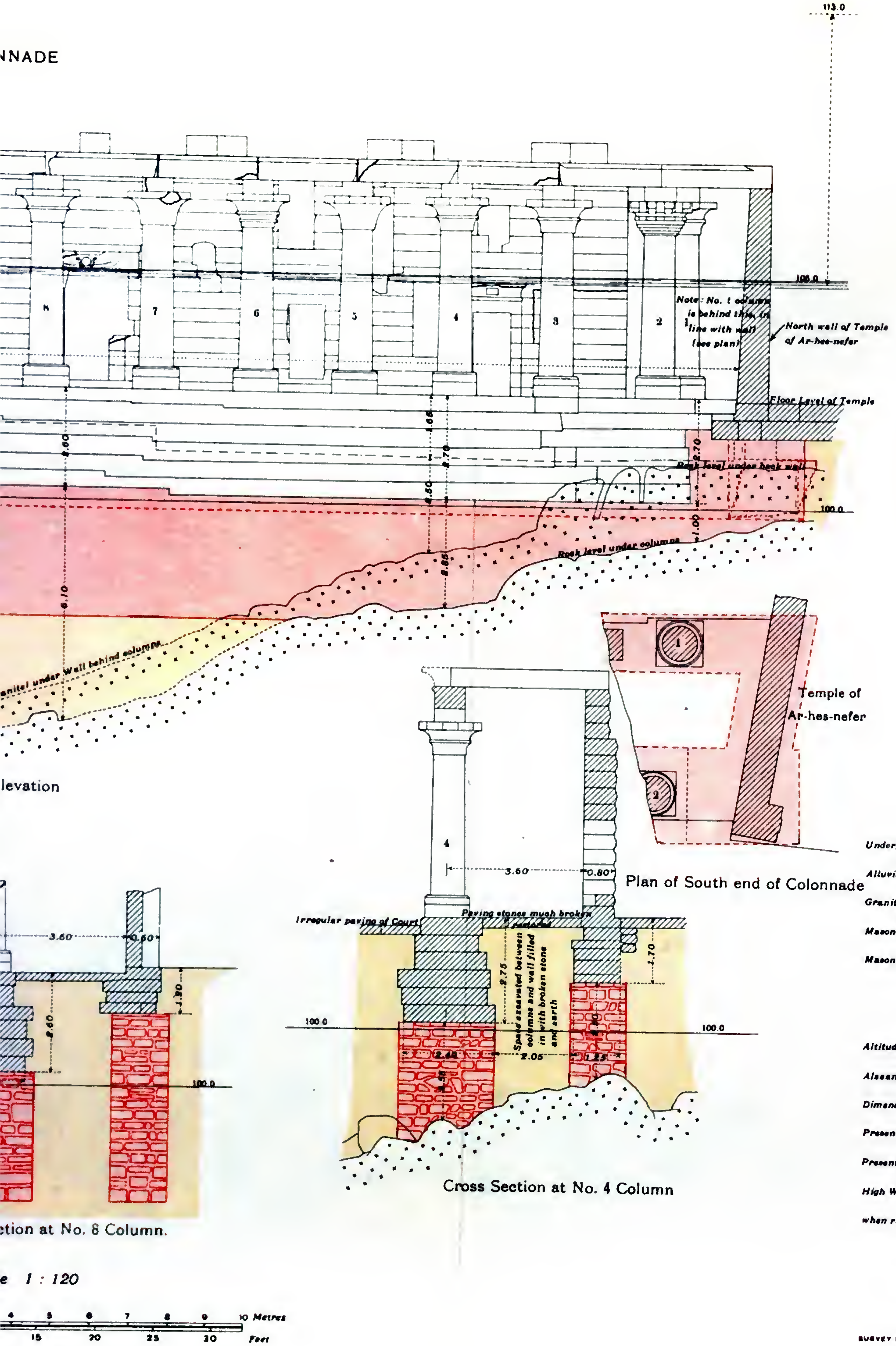
Metres 1 .5 0 1 2 3 4 5
Feet 5 4 3 2 1 0 5 10 15

SURVEYED IN 1901.

SURVEYED AND DRAWN BY DR. J. BALL.

NNADE

PLATE IX.


113.0
106.0
100.0
Note: No. 1 column is behind this, in line with wall (see plan)
North wall of Temple of Ar-hes-nefer
Floor Level of Temple
Rock level under back wall
Rock level under columns
anite) under Wall behind columns
2.60
6.10
1.66
2.70
4.50
8.85
1.00
K
7
6
5
4
3
2
1
Temple of Ar-hes-nefer
Irregular paving of Court
Paving stones much broken restored
Space excavated between columns and wall filled in with broken stone and earth
3.60
0.80
0.60
1.70
2.75
1.20
2.05
1.25
2.45
100.0
4 5 6 7 8 9 10 Metres
15 20 25 30 Feet

levation

Plan of South end of Colonnade

Cross Section at No. 4 Column

ction at No. 8 Column.

e 1 : 120

REFERENCES:

Underpinning	🟥
Alluvial Soil	🟨
Granite	⁖
Masonry in section and plan	▨
Masonry in elevation	▭

Altitudes in metres above sea level at Alexandria, thus 106.0

Dimensions in metres, thus 5.40

Present Low Water Level 91.30

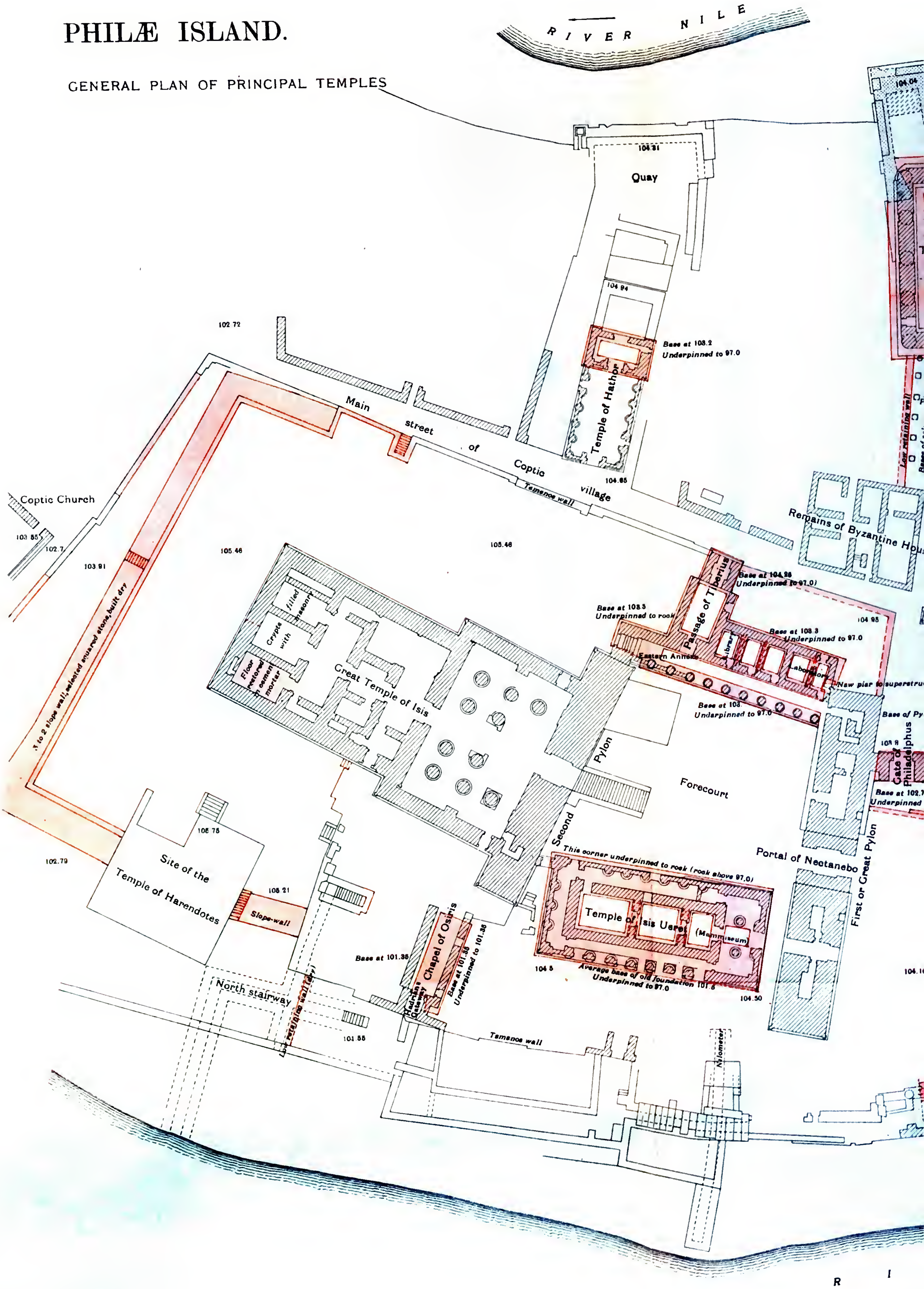
Present High Water Level (1908) 106.0

High Water Level in reservoir when raised 113.0

SURVEY DEPT. CAIRO 1908 (101-119).

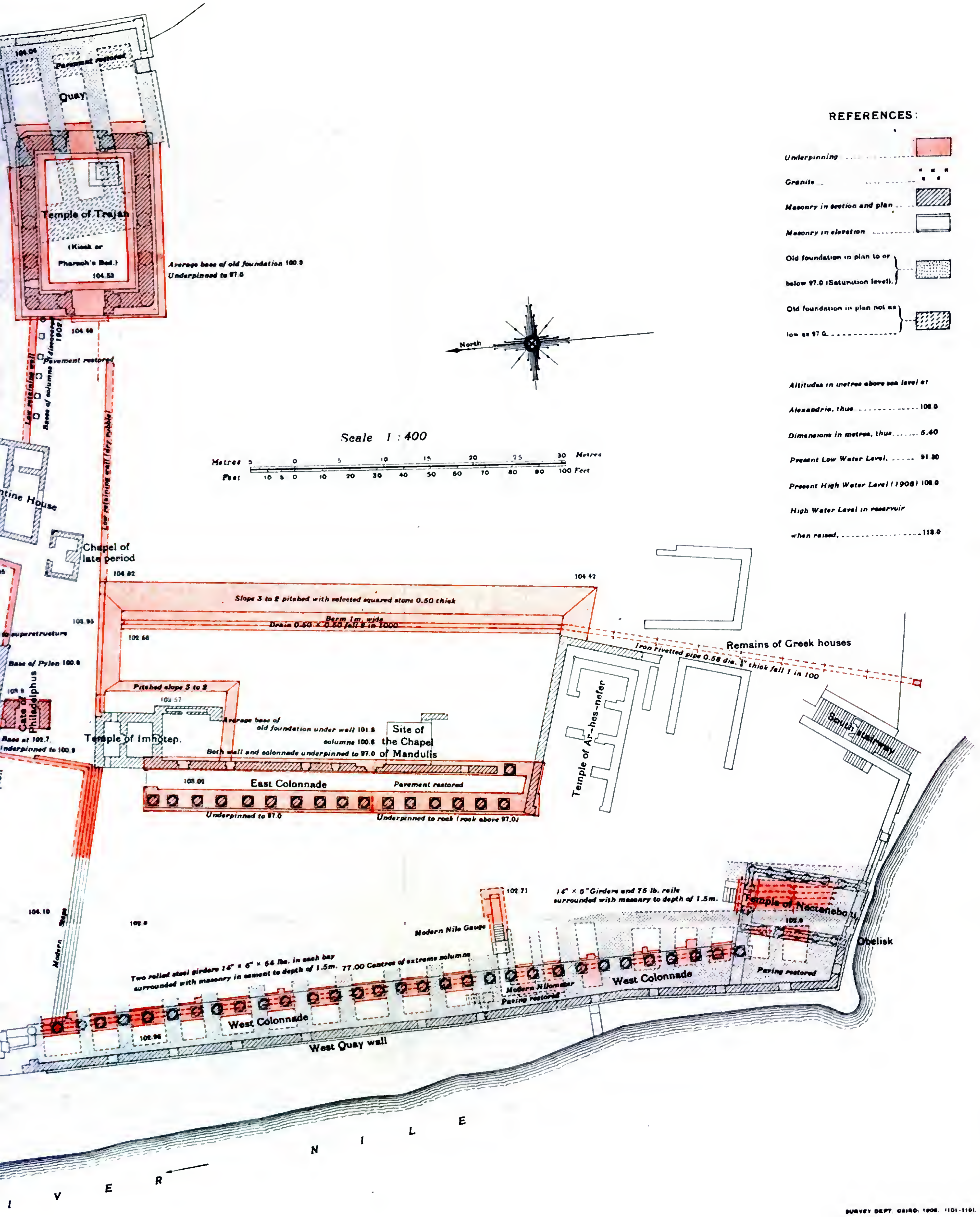
PHILÆ ISLAND.

GENERAL PLAN OF PRINCIPAL TEMPLES



SURVEYED IN 1901.

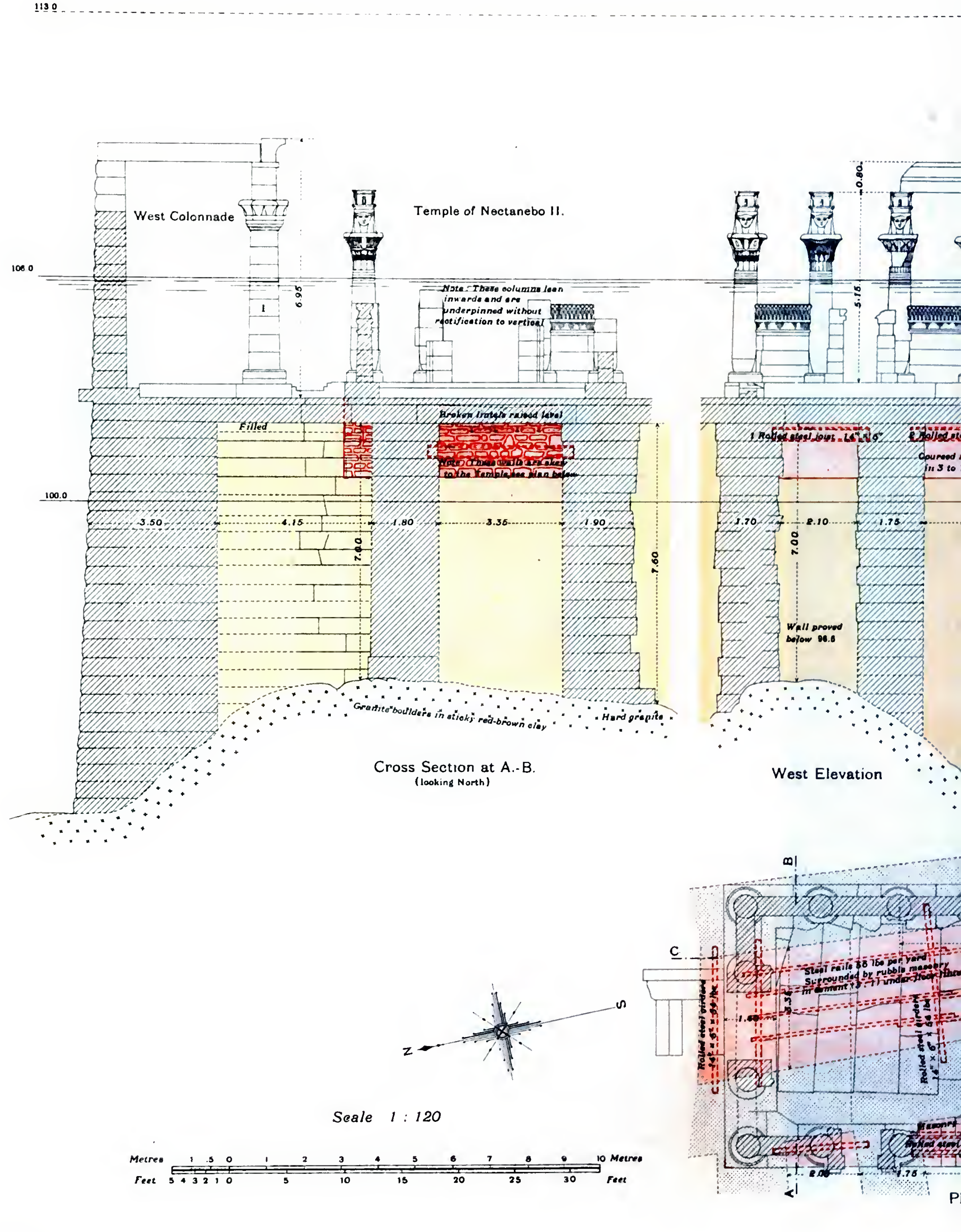
SURVEYED AND DRAWN BY DR. J. BALL.


REFERENCES:
Underpinning
Granite
Masonry in section and plan
Masonry in elevation
Old foundation in plan to or below 97.0 (Saturation level).
Old foundation in plan not as low as 97.0.
Altitudes in metres above sea level at Alexandria, thus 106.0
Dimensions in metres, thus 5.40
Present Low Water Level. 91.30
Present High Water Level (1908) 106.0
High Water Level in reservoir when raised. 118.0
North
Scale 1 : 400
Metres 5 0 5 10 15 20 25 30 Metres
Feet 10 5 0 10 20 30 40 50 60 70 80 90 100 Feet
104.04
Pavement restored
Quay
Temple of Trajan
(Kiosk or Pharaoh's Bed.)
104.53
Average base of old foundation 100.8
Underpinned to 97.0
104.46
Bases of columns discovered 1902
Pavement restored
Low retaining wall
Low retaining wall (dry rubble)
ntine House
Chapel of late period
104.82
104.42
Slope 3 to 2 pitched with selected squared stone 0.50 thick
Berm 1m. wide
Drain 0.50 × 0.50 fall 2 in 1000
103.95
102.66
to superstructure
Base of Pylon 100.8
103.9
Gate of Philadelphus
Base at 102.7.
Underpinned to 100.9
Pitched slope 3 to 2
103.57
Temple of Imhotep.
Average base of old foundation under wall 101.8
columns 100.6
Both wall and colonnade underpinned to 97.0
Site of the Chapel of Mandulis
103.02
East Colonnade
Pavement restored
Underpinned to 97.0
Underpinned to rock (rock above 97.0)
Remains of Greek houses
Iron rivetted pipe 0.58 dia. ¼" thick fall 1 in 100
Temple of Ar-hes-nefer
South stairway
104.10
Modern Steps
102.9
Modern Nile Gauge
102.71
14" × 6" Girders and 75 lb. rails surrounded with masonry to depth of 1.5m.
Temple of Nectanebo II.
102.9
Obelisk
Two rolled steel girders 14" × 6" × 54 lbs. in each bay surrounded with masonry in cement to depth of 1.5m.
77.00 Centres of extreme columns
Modern Nilometer
Paving restored
Paving restored
West Colonnade
West Colonnade
102.96
West Quay wall
R I V E R N I L E

SURVEY DEPT. CAIRO. 1908. (101-1101.

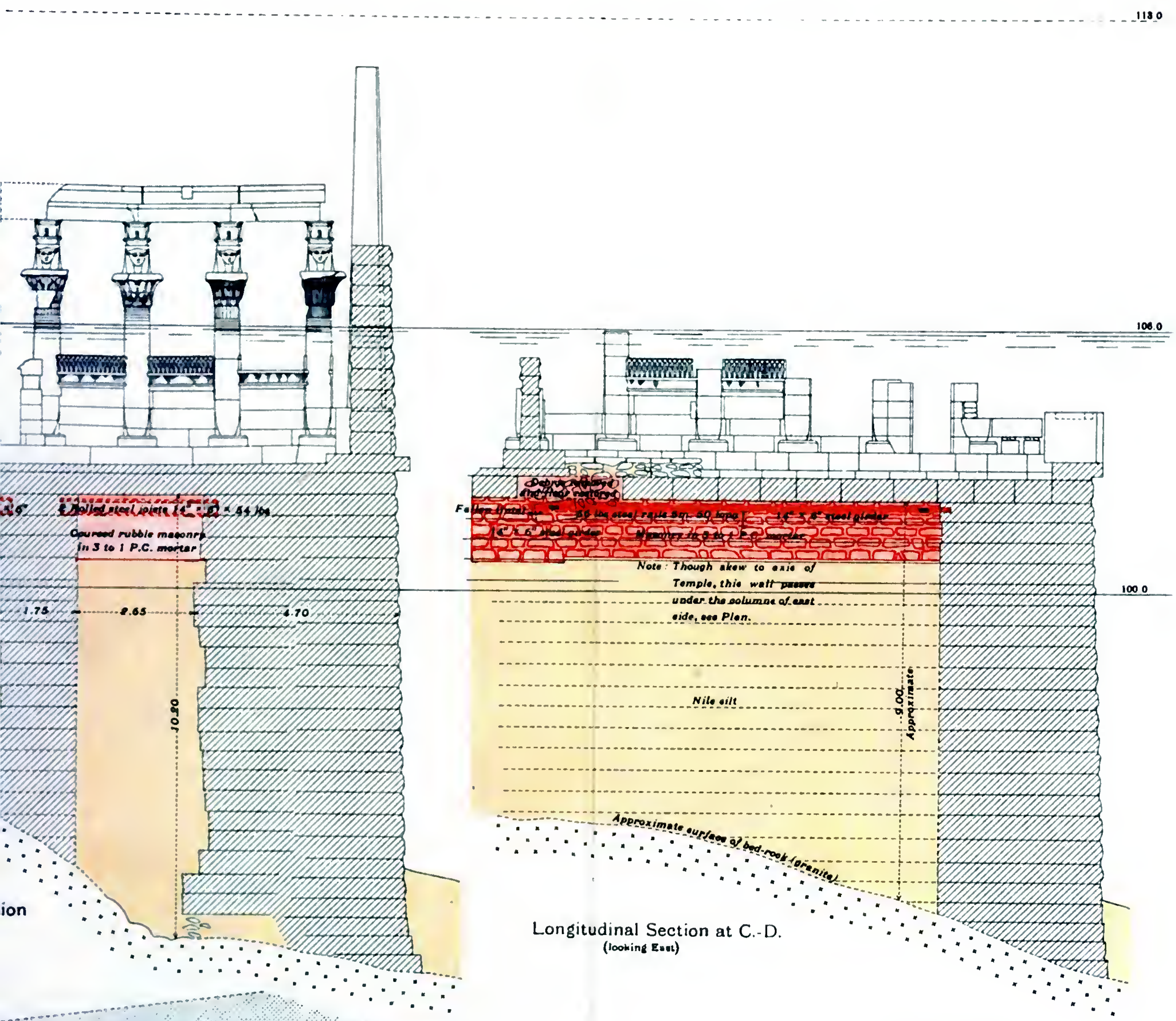
PHILÆ ISLAND.

TEMPLE OF N


113 0
106 0
100.0
West Colonnade
Temple of Nectanebo II.
6.95
Note: These columns lean inwards and are underpinned without rectification to vertical
Filled
Broken lintels raised level
Note: These walls are skew to the Temple, see plan below
3.50
4.15
1.80
3.35
1.90
7.60
7.60
Granite boulders in sticky red-brown clay
Hard granite
Cross Section at A.-B.
(looking North)
0.80
5.15
1 Rolled steel joist 14" × 6"
Coursed
in 3 to
1.70
2.10
1.75
7.00
Wall proved below 96.8
West Elevation
B
C
Steel rails 56 lbs per yard
Surrounded by rubble masonry
in cement
Rolled steel girders 14" × 6" × 64 lbs
Rolled steel girders 14" × 6" × 64 lbs
1.60
3.35
Masonry
Rolled steel
2.00
1.75
A
P
N
S
Scale 1 : 120
Metres 1 .5 0 1 2 3 4 5 6 7 8 9 10 Metres
Feet 5 4 3 2 1 0 5 10 15 20 25 30 Feet

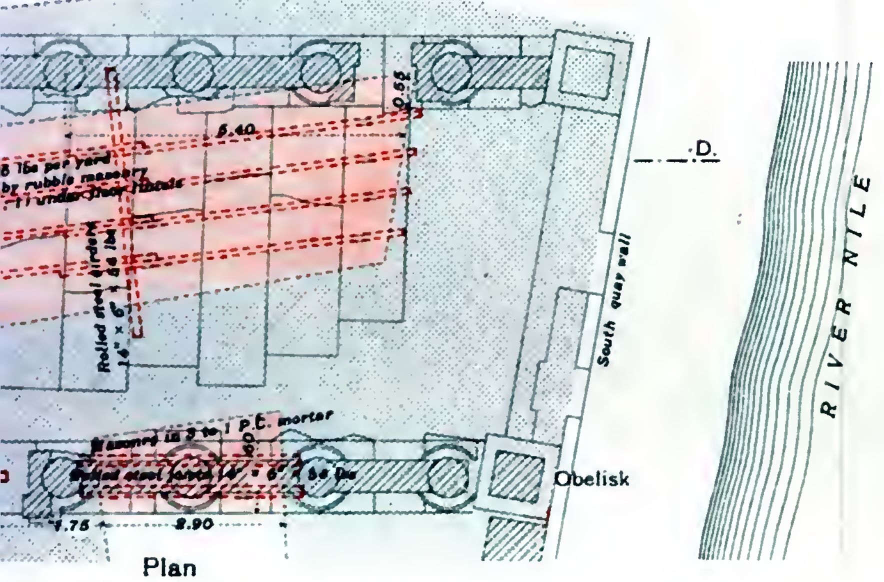
SURVEYED IN 1901.

SURVEYED AND DRAWN BY DR. J. BALL.


113.0
106.0
100.0
5'6"
2 Rolled steel joists 14" × 6" × 54 lbs
Coursed rubble masonry
in 3 to 1 P.C. mortar
1.75
2.65
4.70
10.90
Debris removed and floor restored
Fallen lintel
50 lbs steel rails 5m. 50 long
14" × 6" steel girder
14" × 6" steel girder
Masonry in 3 to 1 P.C. mortar
Note: Though skew to axis of Temple, this wall passes under the columns of east side, see Plan.
Nile silt
9.00
Approximate
Approximate surface of bed-rock (granite)

ion

Longitudinal Section at C.-D.
(looking East)



Plan

REFERENCES:

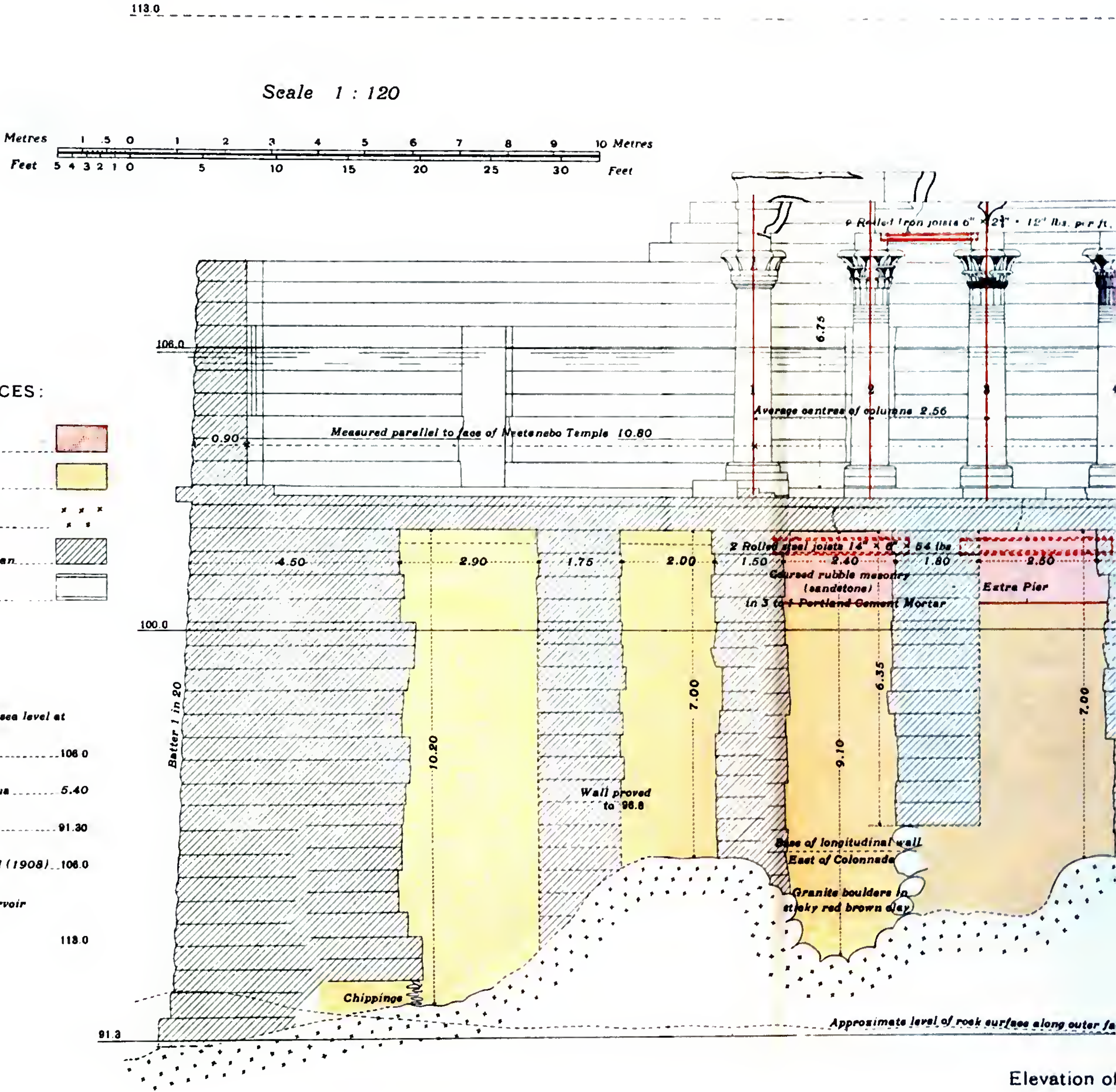
Underpinning	☐
Alluvial Soil	🟨
Granite	⁖
Masonry in section and plan	▨
Masonry in elevation	☐
Old foundation in plan to or below 97.0 (Saturation level)	░

Altitudes in metres above sea level at Alexandria thus	106.0
Dimensions in metres, thus	5.40
Present Low Water Level	91.30
Present High Water Level (1908)	106.0
High Water Level in reservoir when raised	113.0

SURVEY DEPT. CAIRO: 1908. (101-110).

PHILÆ ISLAND.

WEST COLON



113.0
Scale 1 : 120
Metres 1 .5 0 1 2 3 4 5 6 7 8 9 10 Metres
Feet 5 4 3 2 1 0 5 10 15 20 25 30 Feet
106.0
100.0
91.3
0.90
Measured parallel to face of Nectanebo Temple 10.80
Average centres of columns 2.56
6.75
1
2
3
2 Rolled iron joists 6" × 2½" · 12 lbs. per ft.
4.50
2.90
1.75
2.00
1.50
2.40
1.80
2.50
2 Rolled steel joists 14" × 6" × 54 lbs
Coursed rubble masonry (sandstone) in 3 to 1 Portland Cement Mortar
Extra Pier
Batter 1 in 20
10.20
7.00
6.35
9.10
7.00
Wall proved to 98.8
Base of longitudinal wall East of Colonnade
Granite boulders in sticky red brown clay
Chippings
Approximate level of rock surface along outer fa

Elevation of

Pavement an

REFERENCES:

Underpinning	🟥
Alluvial Soil	🟨
Granite	× × ×
Masonry in section and plan	▨
Masonry in elevation	☐

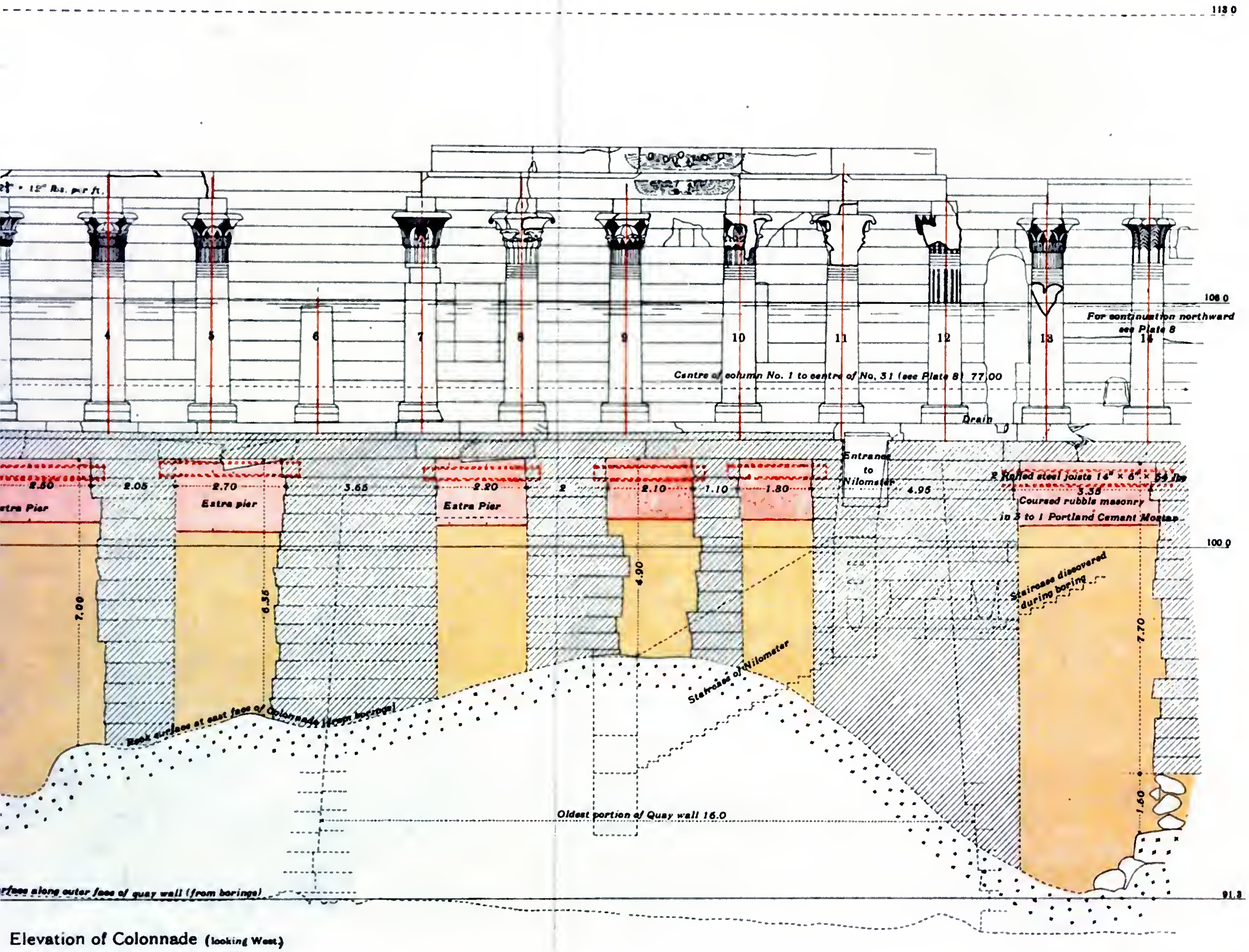
Altitudes in metres above sea level at Alexandria, thus	106.0
Dimensions in metres, thus	5.40
Present Low Water Level,	91.30
Present High Water Level (1908)	106.0
High Water Level in reservoir when raised,	113.0

SURVEYED IN 1901.

SURVEYED AND DRAWN BY DR. J. BALL.

PLATE VII.

EST COLONNADE (Southern half)


113.0
…t × 12" lbs. per ft.
4
5
6
7
8
9
10
11
12
13
14
106.0
For continuation northward see Plate 8
Centre of column No. 1 to centre of No. 31 (see Plate 8) 77.00
Drain
Entrance to Nilometer
2.50
…tra Pier
2.05
2.70
Extra pier
3.65
2.20
Extra Pier
2
2.10
1.10
1.80
4.95
2 Rolled steel joists 14" × 6" × 54 lbs
3.35
Coursed rubble masonry in 3 to 1 Portland Cement Mortar
100.0
7.00
6.35
4.90
Staircase discovered during boring
7.70
1.60
Staircase of Nilometer
Rock surface at east face of Colonnade (from borings)
Oldest portion of Quay wall 16.0
…rface along outer face of quay wall (from borings)
91.3

Elevation of Colonnade (looking West.)

Pavement and foundation walls in section

SURVEY DEPT. CAIRO: 1908. (101-110)

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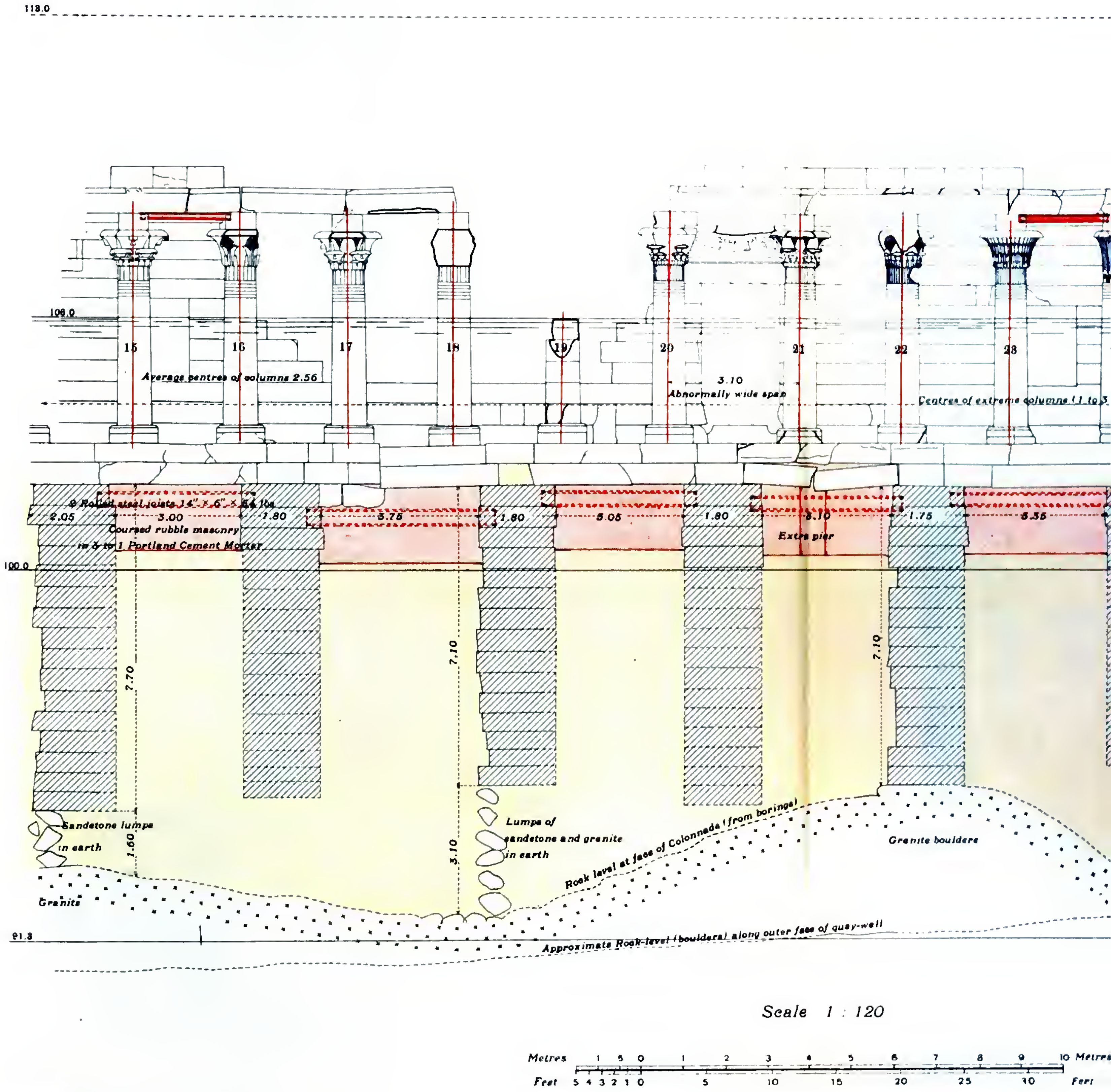
WEST COLONNADE (Northern h


113.0
106.0
100.0
91.8
15
16
17
18
19
20
21
22
23
Average centres of columns 2.56
3.10
Abnormally wide span
Centres of extreme columns (1 to 3
2 Rolled steel joists 14" × 6" × 54 lbs
2.05
3.00
1.80
3.75
1.80
5.05
1.80
5.10
1.75
5.35
Coursed rubble masonry
in 3 to 1 Portland Cement Mortar
Extra pier
7.70
7.10
7.10
1.60
3.10
Sandstone lumps
in earth
Granite
Lumps of
sandstone and granite
in earth
Rock level at face of Colonnade (from borings)
Granite boulders
Approximate Rock-level (boulders) along outer face of quay-wall
Metres 1 5 0 1 2 3 4 5 6 7 8 9 10 Metres
Feet 5 4 3 2 1 0 5 10 15 20 25 30 Feet

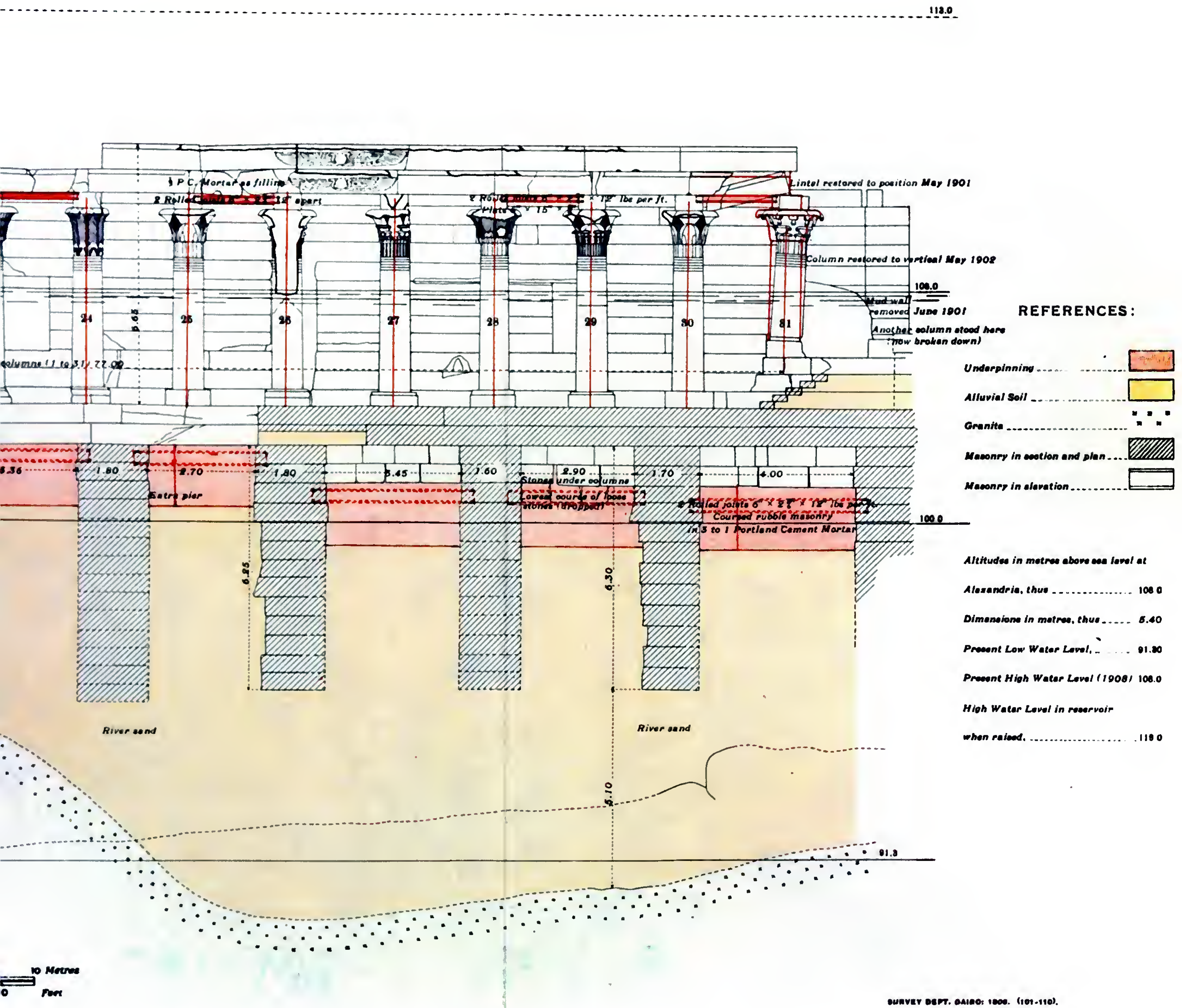
Scale 1 : 120

SURVEYED IN 1901.

SURVEYED AND DRAWN BY DR. J. BALL.

Northern half)

PLATE VIII.


113.0
⅓ P.C. Mortar as filling
2 Rolled joists ... 12" apart
2 Rolled joists ... 12" lbs per ft.
Plate ... 15"
Lintel restored to position May 1901
Column restored to vertical May 1902
108.0
Mud wall removed June 1901
Another column stood here (now broken down)
24
25
26
27
28
29
30
31
5.65
columns (1 to 31) 77.00
5.36
1.80
2.70
1.80
3.45
1.60
2.90
1.70
4.00
Extra pier
Stones under columns
Lowest course of loose stones (dropped)
2 Rolled joists 6" × 2⅞" × 12" lbs per ft.
Coursed rubble masonry
in 3 to 1 Portland Cement Mortar
100.0
6.25
6.30
5.10
River sand
River sand
91.3
10 Metres
0
Feet

REFERENCES:

Underpinning	🟥
Alluvial Soil	🟨
Granite	∴
Masonry in section and plan	▨
Masonry in elevation	☐

Altitudes in metres above sea level at

Alexandria, thus 108.0

Dimensions in metres, thus 5.40

Present Low Water Level, ... 91.30

Present High Water Level (1908) 108.0

High Water Level in reservoir

when raised. 113.0

SURVEY DEPT. CAIRO: 1908. (101-110).

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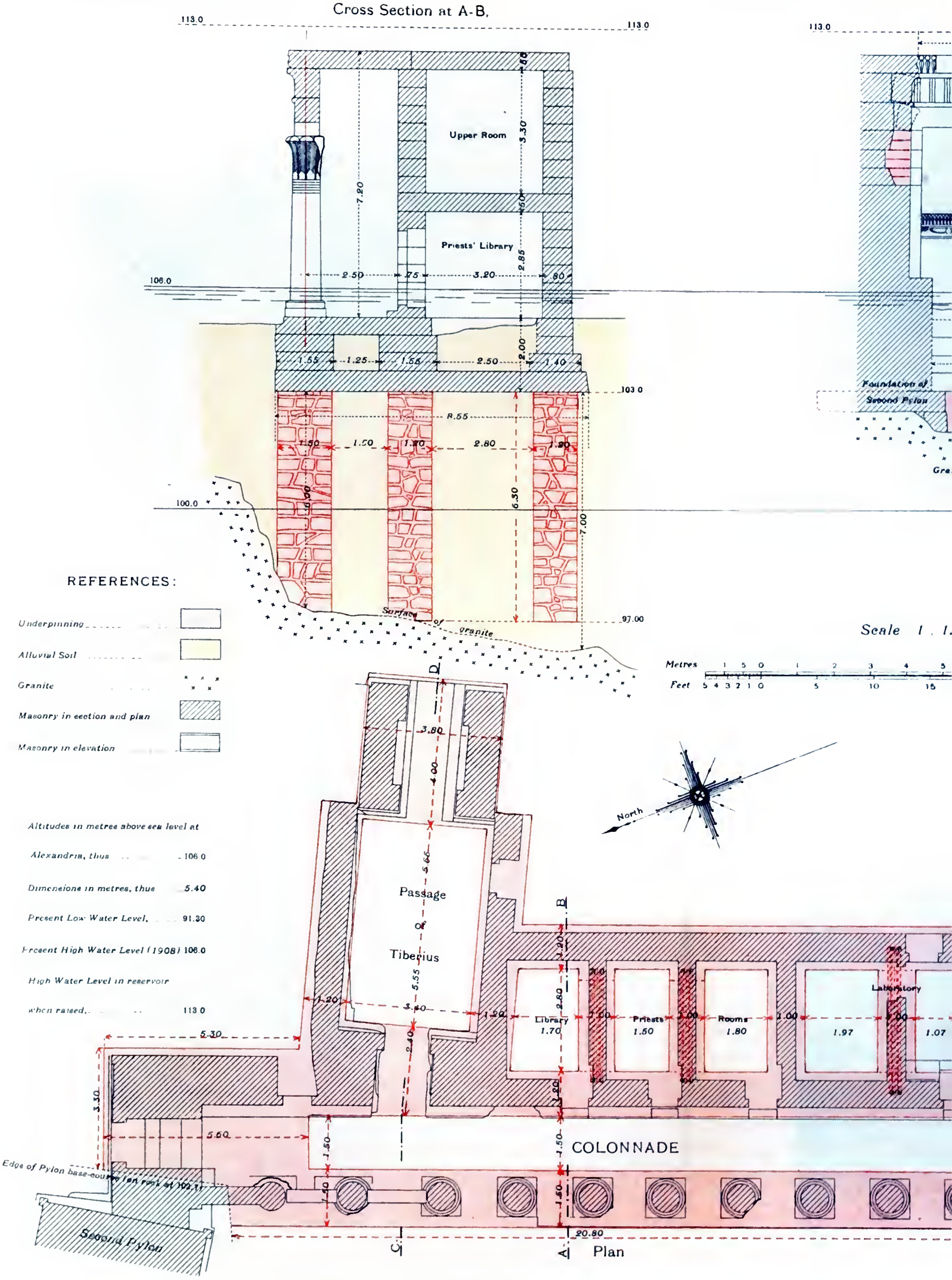
EASTERN ANNEXE OF TE



REFERENCES:

Underpinning	▭
Alluvial Soil	▭
Granite	⁖
Masonry in section and plan	▨
Masonry in elevation	▭

Altitudes in metres above sea level at

Alexandria, thus	106.0
Dimensions in metres, thus	*5.40*
Present Low Water Level,	91.30
Present High Water Level (1908)	106.0
High Water Level in reservoir when raised,	113.0

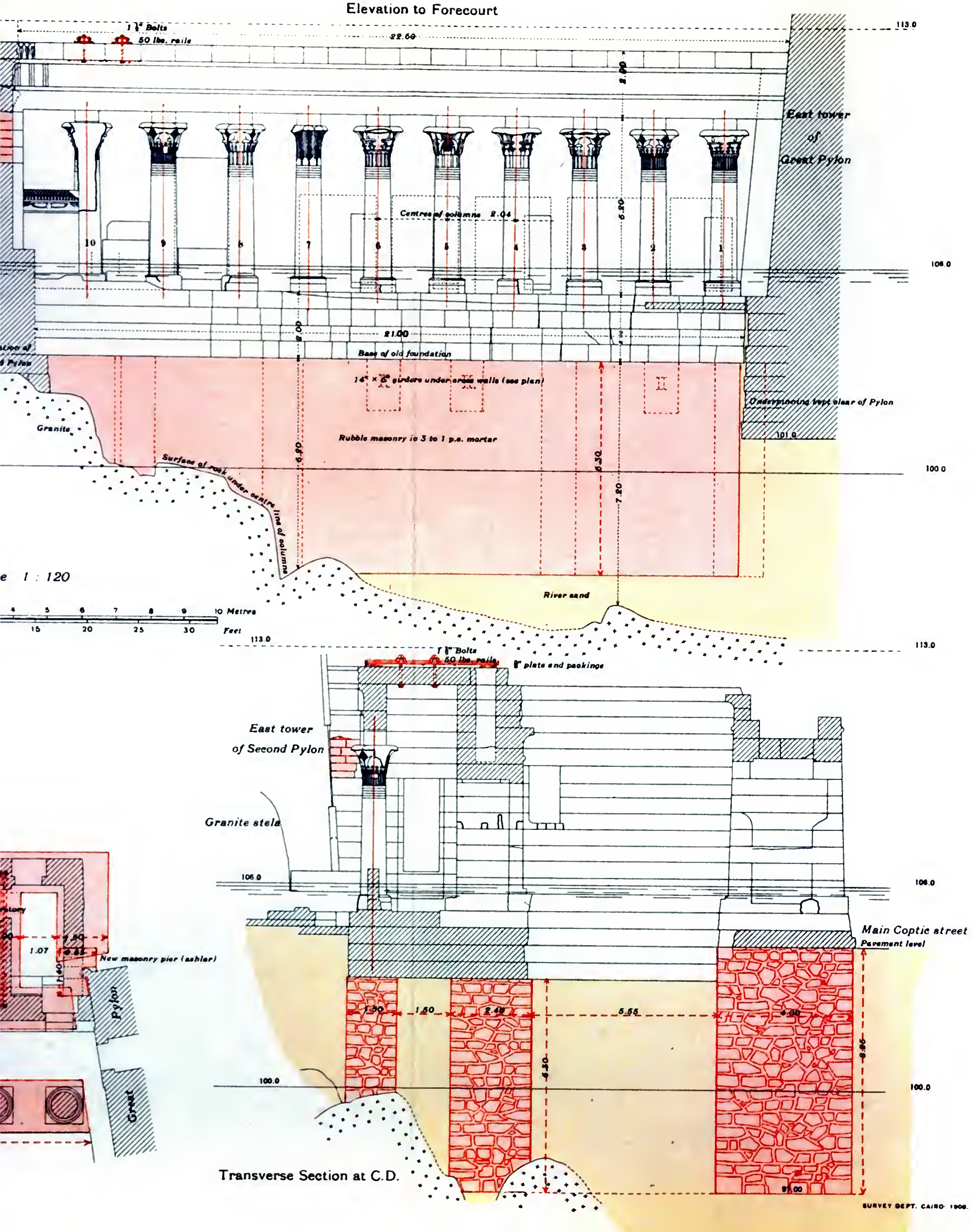
SURVEYED AND DRAWN BY Dr J BALL.

F TEMPLE OF ISIS

PLATE X.

Elevation to Forecourt

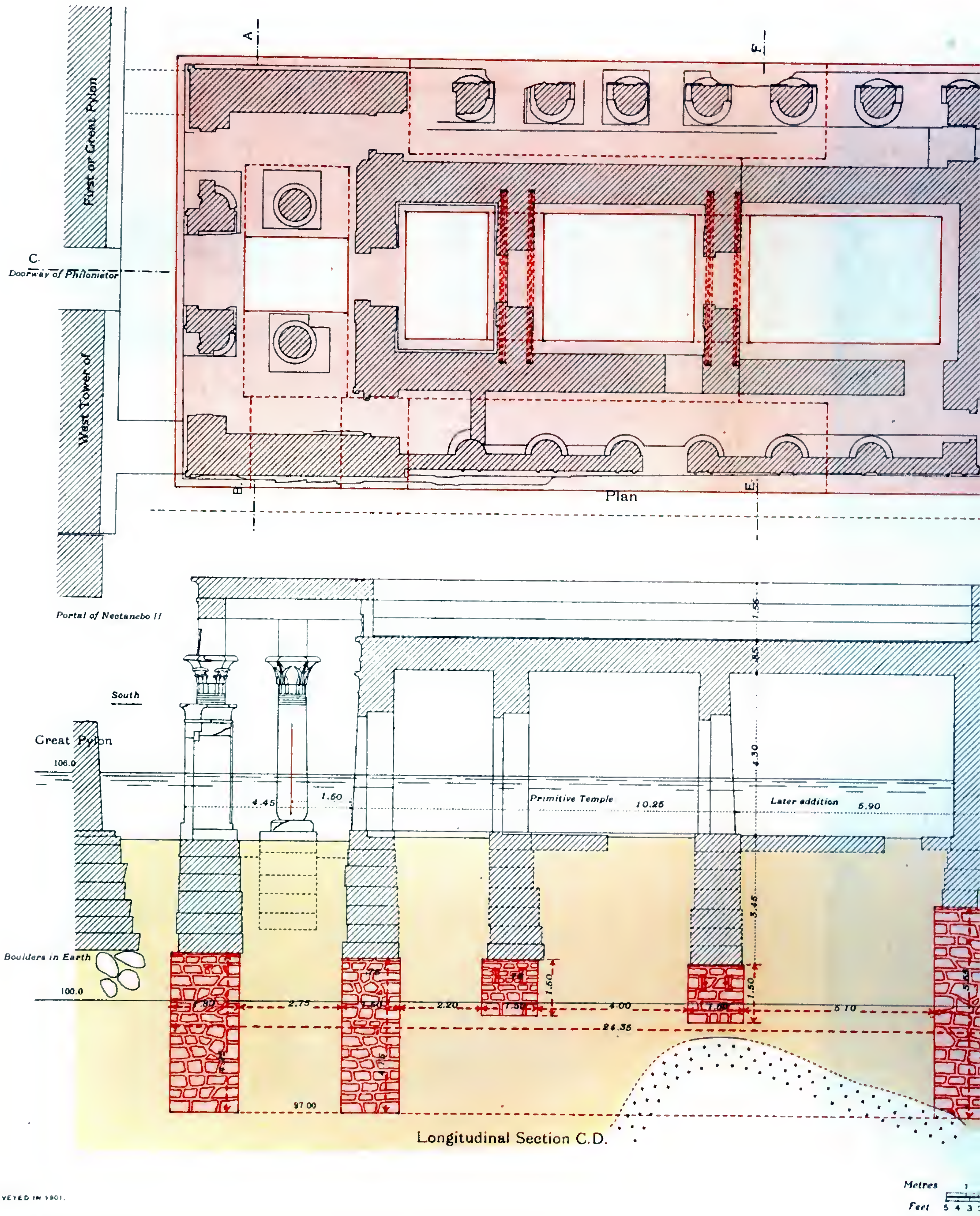
Transverse Section at C.D.



SURVEY DEPT. CAIRO 1908. (101-110).

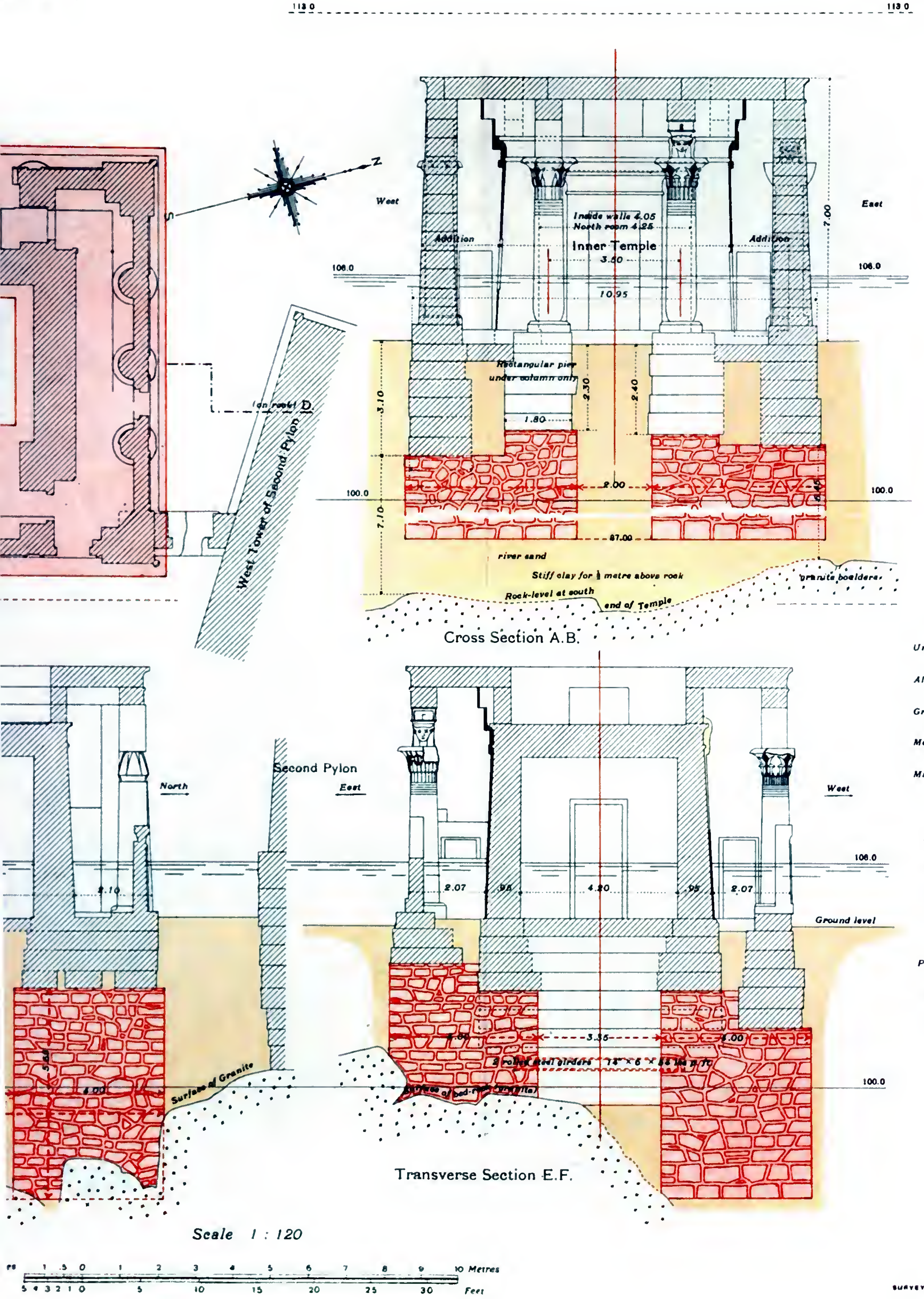
PHILÆ ISLAND.

TEMPLE OF ISIS USRET. (The Mammis



SURVEYED IN 1901.

SURVEYED AND DRAWN BY DR J. BALL



REFERENCES:

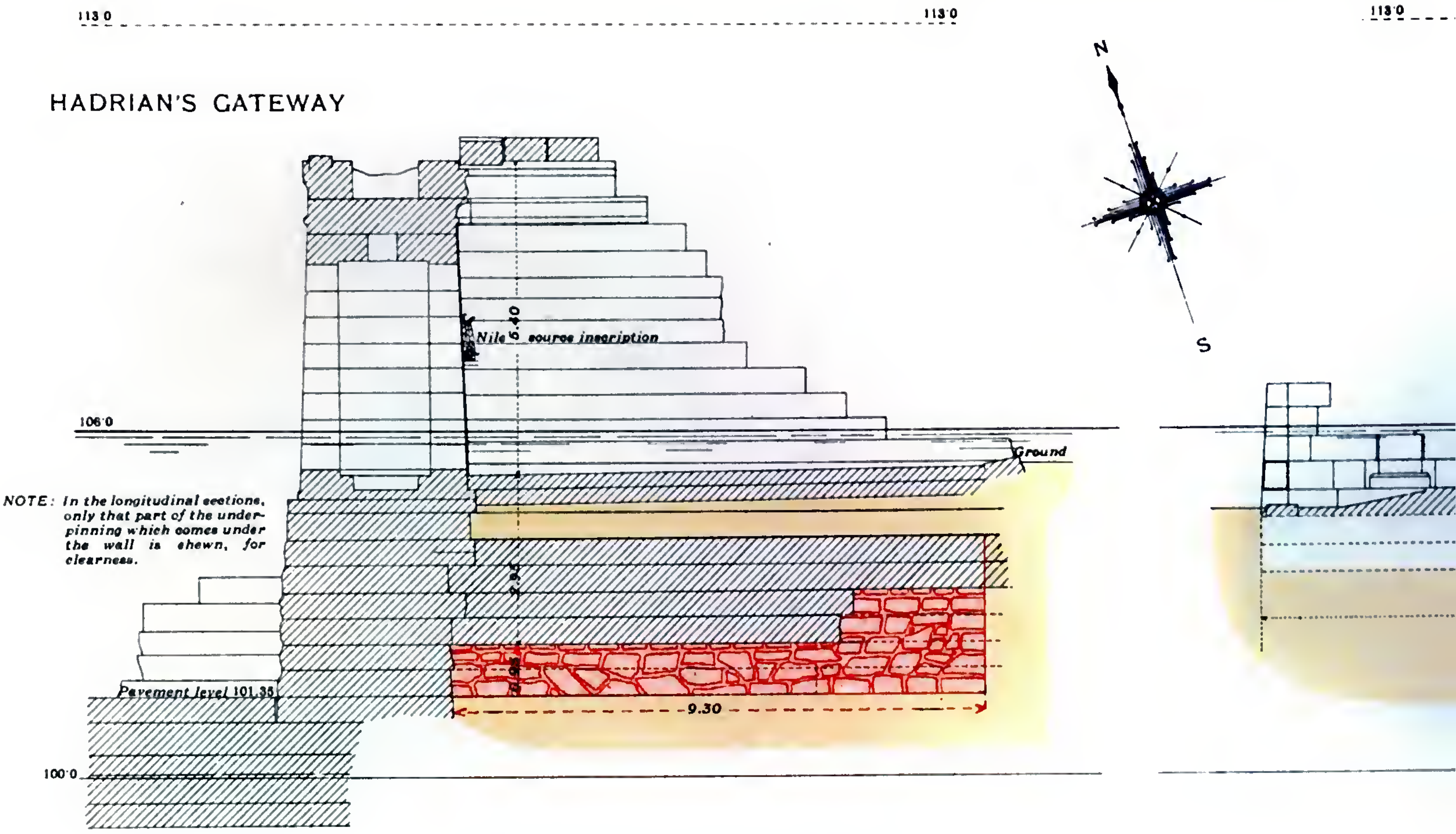
Underpinning .... 🟥
Alluvial Soil .... 🟨
Granite .... ⁘
Masonry in section and plan .... ▨
Masonry in elevation .... ☐

Altitudes in metres above sea level at Alexandria, thus 106.0
Dimensions in metres, thus 5.40
Present Low Water Level, ... 91.30
Present High Water Level (1908) 106.0
High Water Level in reservoir when raised, ... 113.0

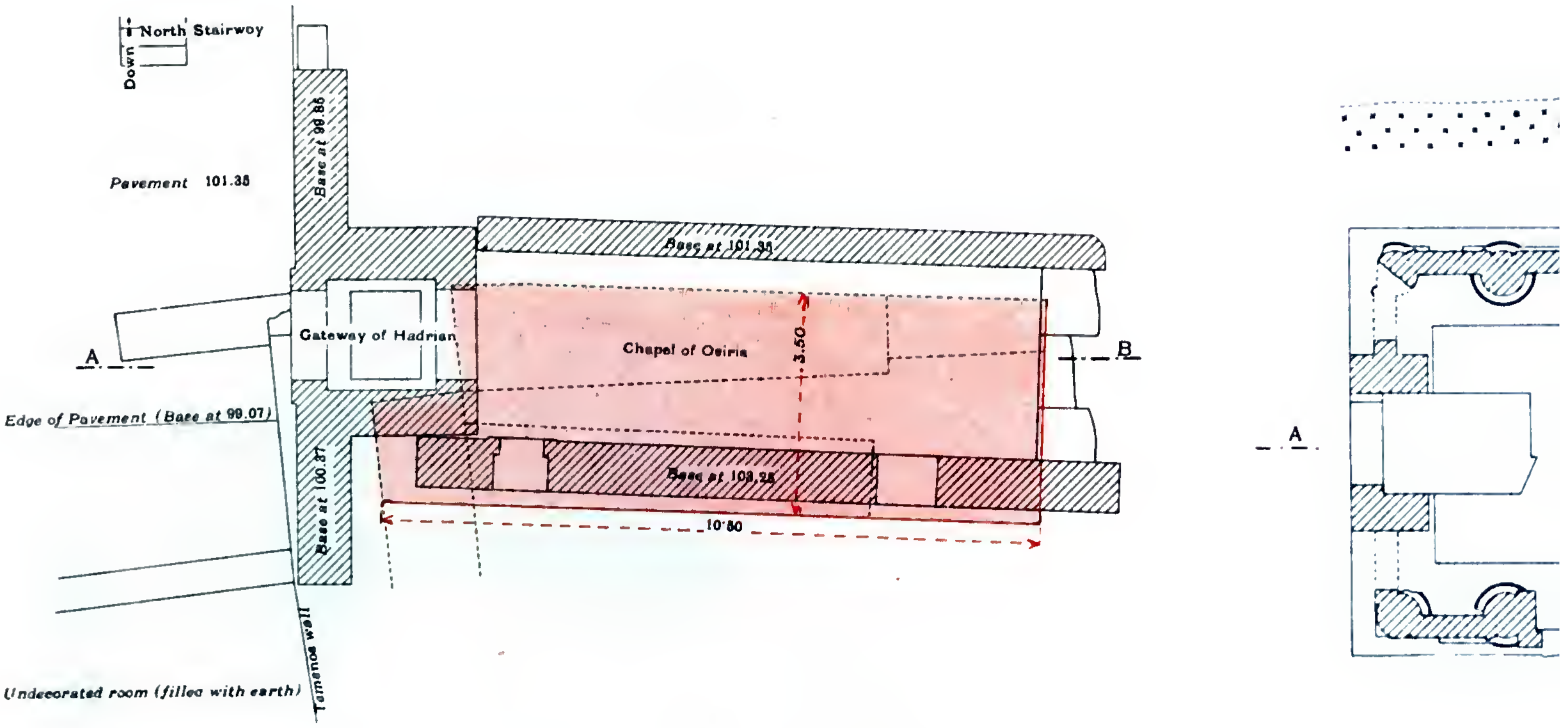
SURVEY DEPT. CAIRO 1908 (101-110)

PHILÆ ISLAND.

HADRIAN'S GATEWAY

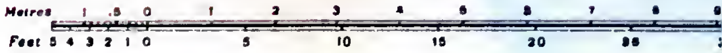

113 0
113 0
113 0
N
S
6.40
Nile source inscription
106 0
Ground
NOTE: In the longitudinal sections, only that part of the underpinning which comes under the wall is shewn, for clearness.
2.94
2.26
Pavement level 101.35
9.30
100 0

Longitudinal Section at A. B. (looking North)



Plan

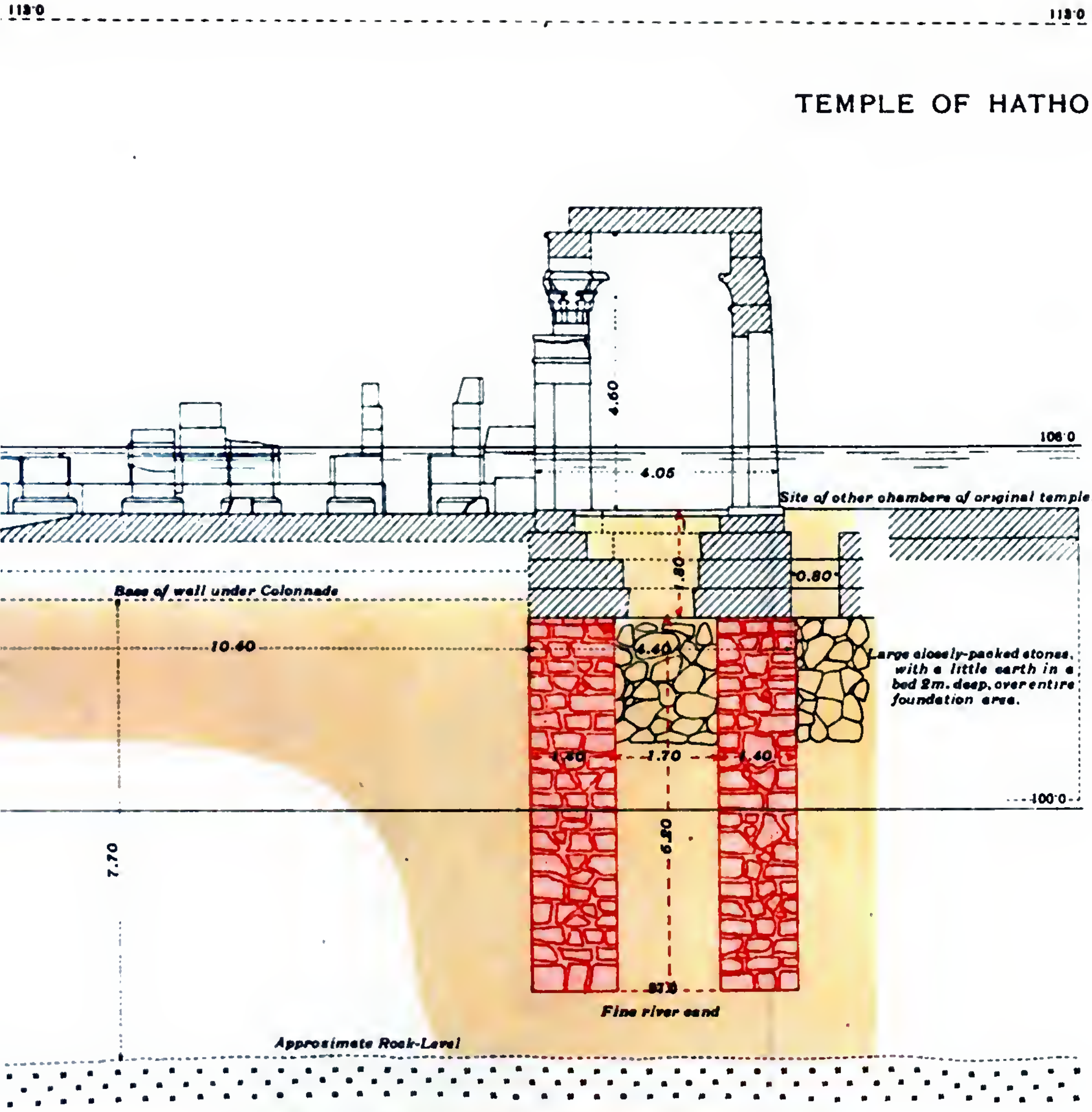
Scale 1 : 120


Metres 1 .5 0 1 2 3 4 5 6 7 8 9
Feet 5 4 3 2 1 0 5 10 15 20 25

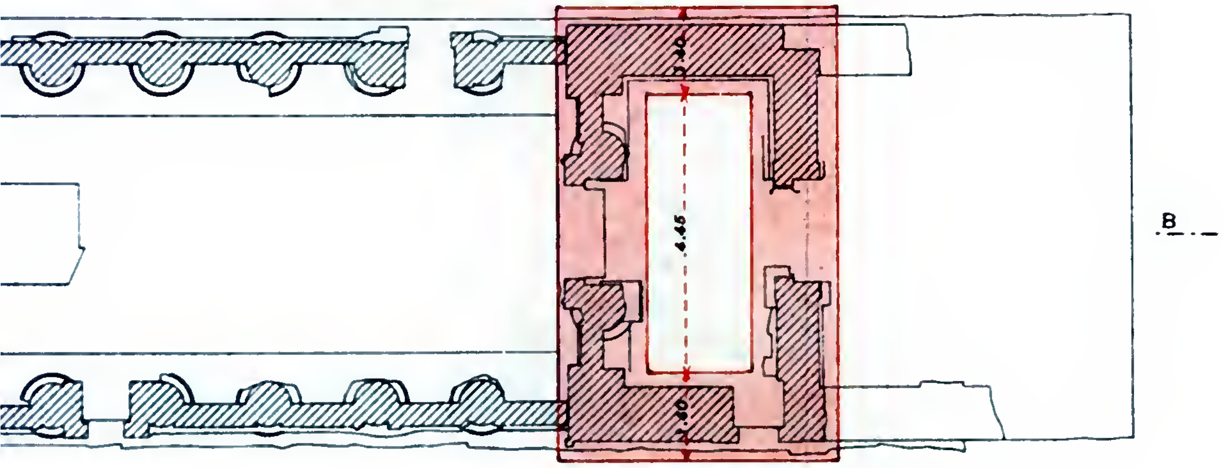
SURVEYED IN 1901

SURVEYED AND DRAWN BY DR J. BALL

TEMPLE OF HATHOR


113·0
113·0
4.60
4.05
106·0
Site of other chambers of original temple.
1.80
0.80
Base of wall under Colonnade
10.40
4.40
Large closely-packed stones, with a little earth in a bed 2m. deep, over entire foundation area.
1.60
1.70
1.40
100·0
7.70
6.90
Fine river sand
Approximate Rock-Level

Longitudinal Section at A B. (looking North)



Plan

REFERENCES:

Underpinning	🟥
Alluvial Soil	🟨
Granite	⁘
Masonry in section and plan	▨
Masonry in elevation	▭

Altitudes in metres above sea level at

Alexandria, thus 106.0

Dimensions in metres, thus ...5.40

Present Low Water Level, ...91.30

Present High Water Level (1908) 106.0

High Water Level in reservoir

when raised, ...113.0

SURVEY DEPT. CAIRO, 1908. (101-110)

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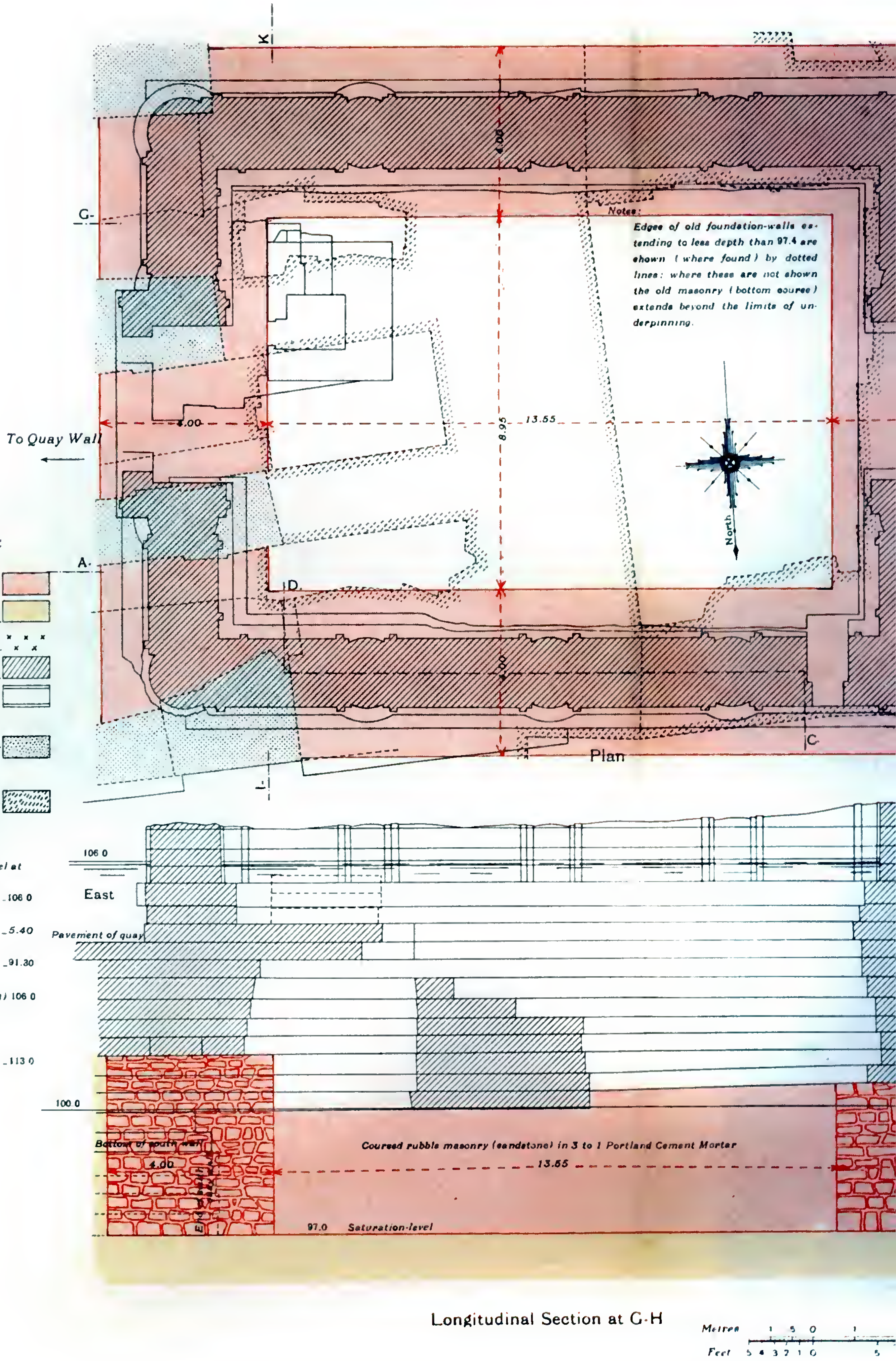
TEMPLE O



Notes:

Edges of old foundation-walls extending to less depth than 97.4 are shown (where found) by dotted lines: where these are not shown the old masonry (bottom course) extends beyond the limits of underpinning.

Plan

Longitudinal Section at G-H

REFERENCES:

Underpinning	🟥
Alluvial Soil	🟨
Granite	× × × × ×
Masonry in section and plan	▨
Masonry in elevation	☐
Old foundation in plan to or below 97.0 (Saturation level).	▒
Old foundation in plan not as low as 97.0	▨

Altitudes in metres above sea level at Alexandria, thus 106 0

Dimensions in metres, thus 5.40

Present Low Water Level 91.30

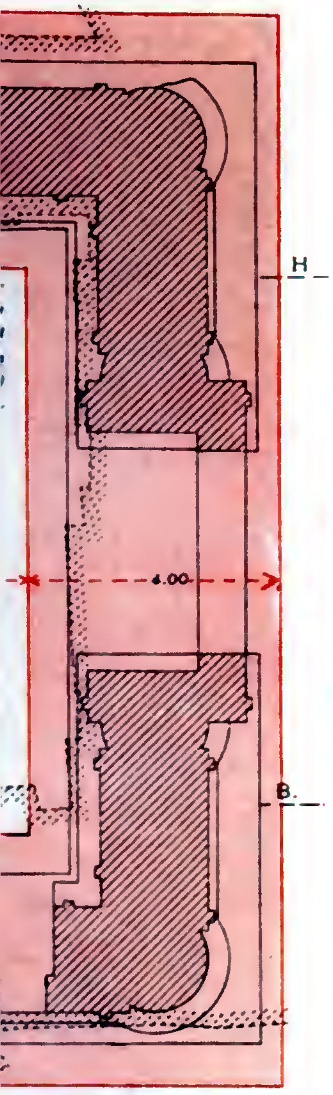
Present High Water Level (1908) 106 0

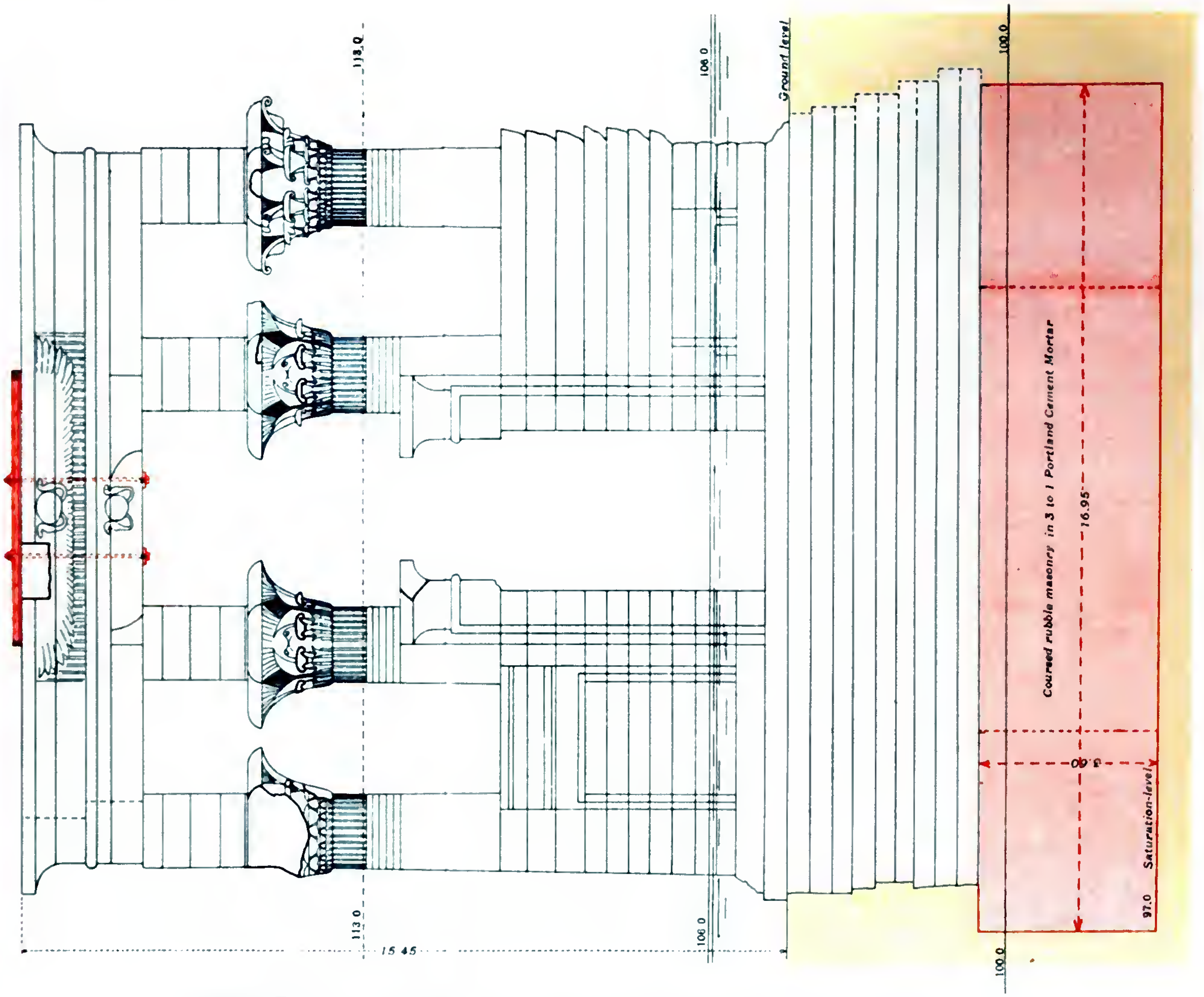
High Water Level in reservoir when raised 113 0

SURVEYED IN 1901

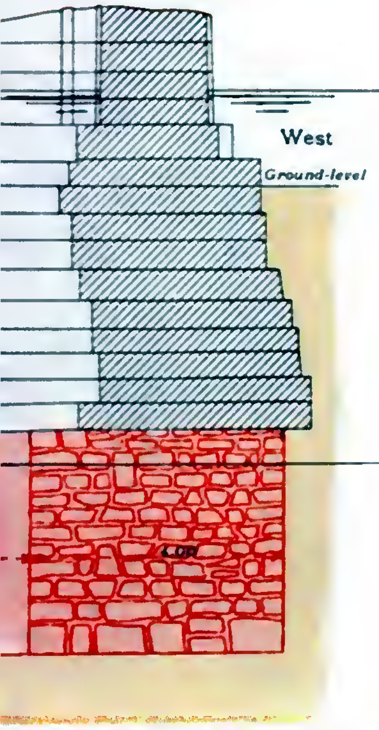
SURVEYED AND DRAWN BY DR. J. BALL

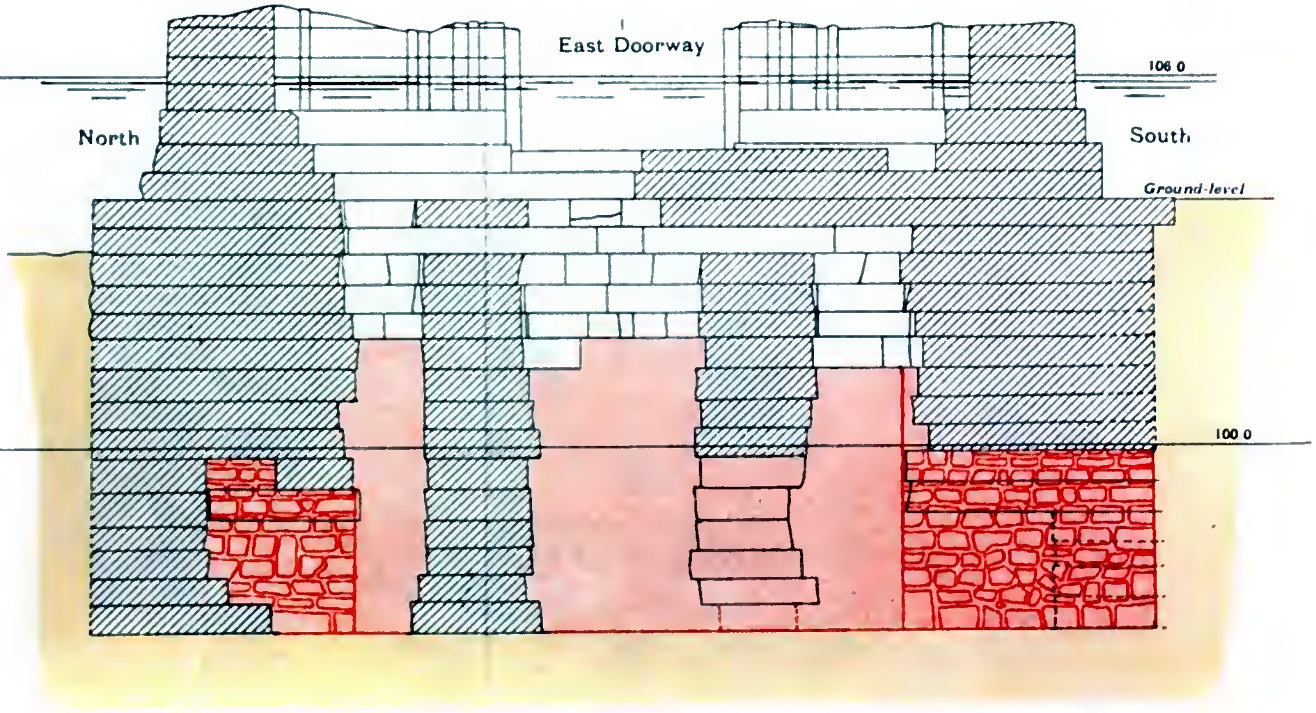
MPLE OF TRAJAN (The Kiosk or Pharaoh's Bed)





West Elevation





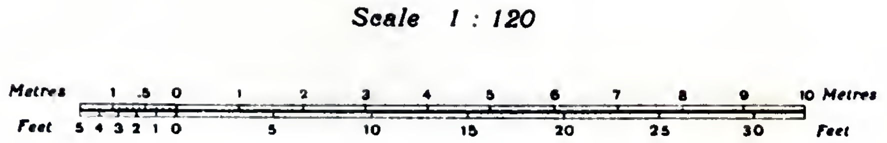
Scale 1 : 120

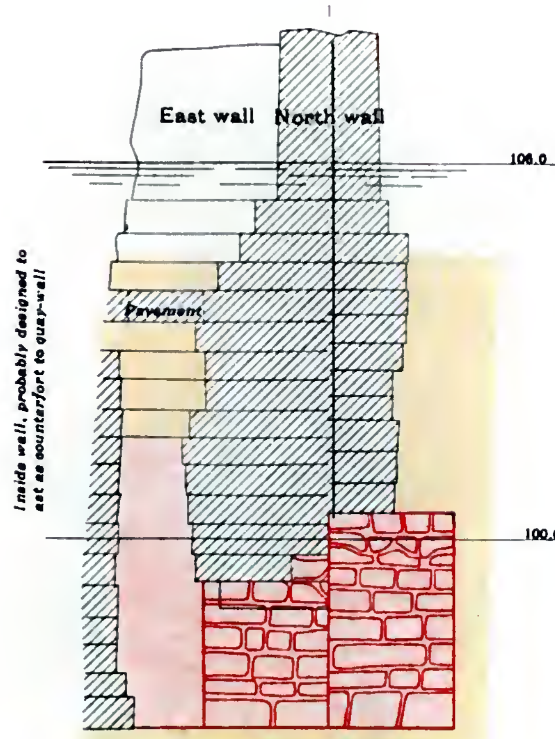
Transverse Section at I-K

SURVEY DEPT CAIRO 1908 (101-110)

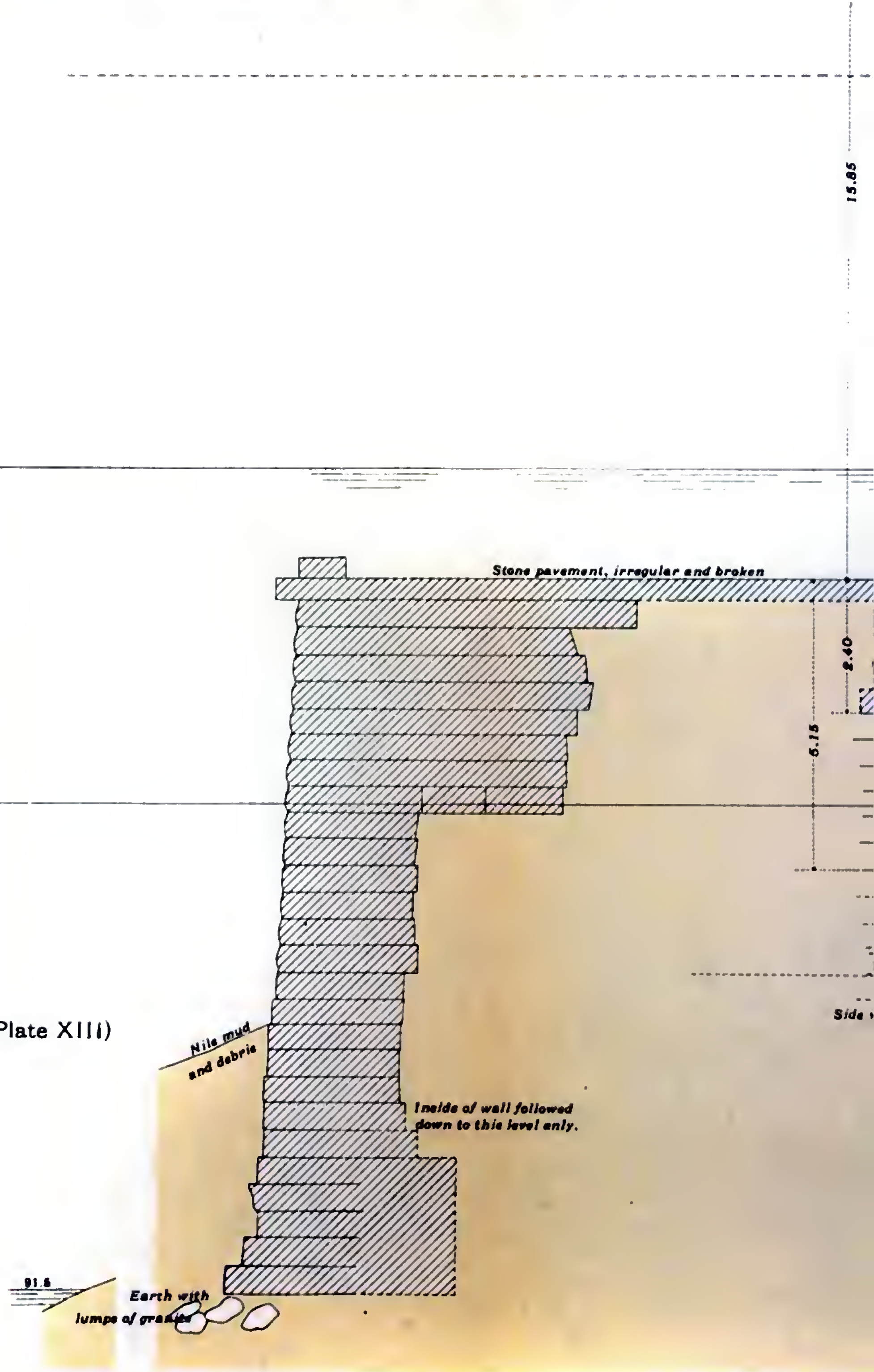
PHILÆ ISLAND.

TEMPLE OF TRAJAN Longit


Scale 1 : 120
Metres 1 .5 0 1 2 3 4 5 6 7 8 9 10 Metres
Feet 5 4 3 2 1 0 5 10 15 20 25 30 Feet


113.0
East wall
North wall
106.0
Pavement
Inside wall, probably designed to act as counterfort to quay-wall
100.0

Cross Section at C.D. of north wall (see Plan, Plate XIII)

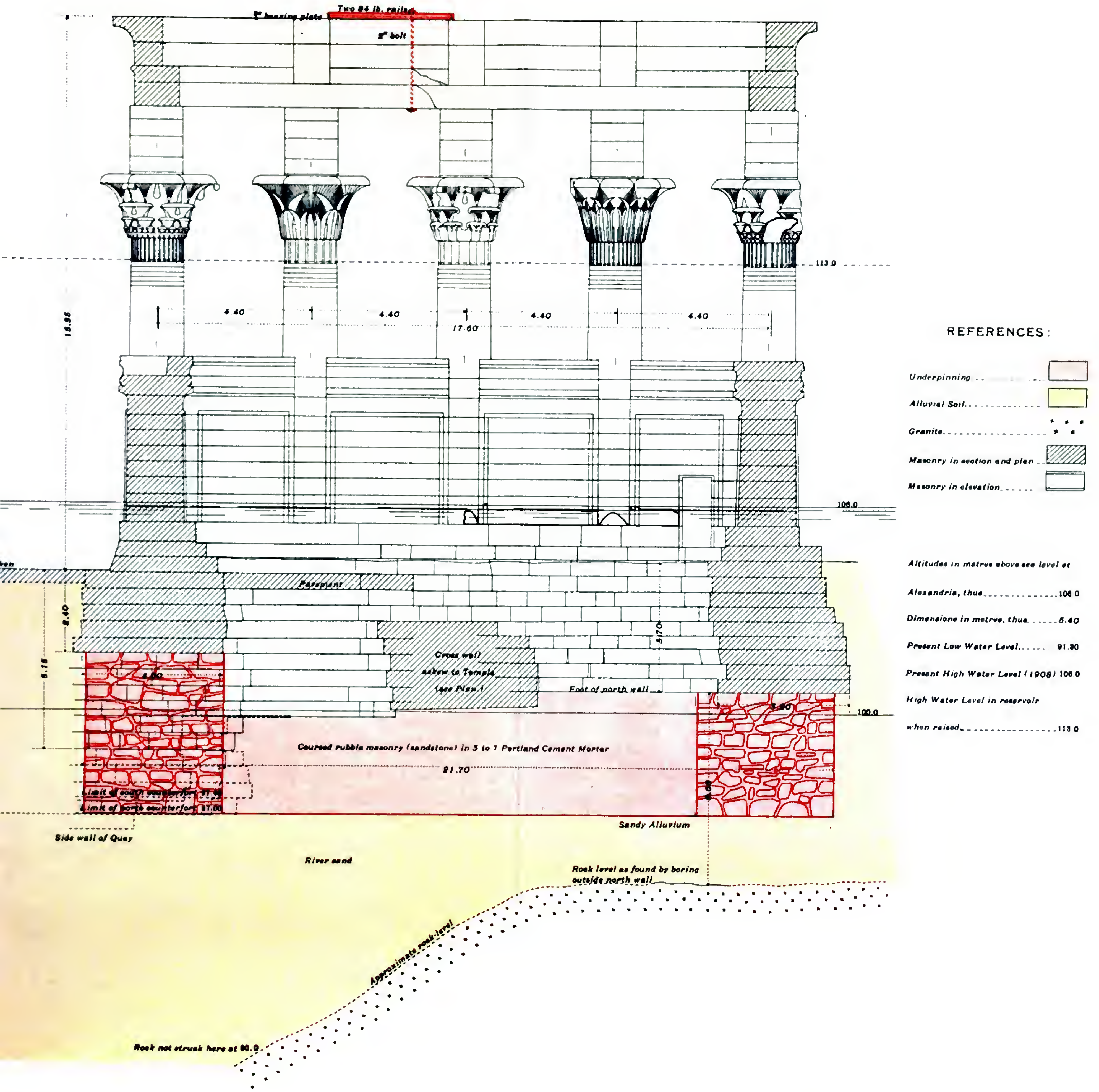

15.85
Stone pavement, irregular and broken
2.40
5.15
100.0
Side
Nile mud and debris
Inside of wall followed down to this level only.
91.5
Earth with lumps of granite

SURVEYED IN 1901.

SURVEYED AND DRAWN BY DR J BALL

PLATE XIV.

N Longitudinal Section showing Quay wall (see Plan, Plate XIII)


3" bearing plate
Two 84 lb. rails
2" bolt
113.0
4.40
4.40
17.60
4.40
4.40
15.85
106.0
Parapet
2.40
6.15
4.00
Cross wall
askew to Temple
(see Plan.)
3.70
Foot of north wall
5.60
100.0
Coursed rubble masonry (sandstone) in 3 to 1 Portland Cement Mortar
21.70
Limit of south counterfort 91.00
Limit of north counterfort 91.00
Side wall of Quay
Sandy Alluvium
River sand
Rock level as found by boring outside north wall
Approximate rock-level
Rock not struck here at 90.0
REFERENCES:
Underpinning
Alluvial Soil
Granite
Masonry in section and plan
Masonry in elevation
Altitudes in metres above sea level at
Alexandria, thus 106.0
Dimensions in metres, thus 5.40
Present Low Water Level, 91.30
Present High Water Level (1908) 106.0
High Water Level in reservoir
when raised 113.0

SURVEY DEPT. CAIRO: 1908. (101-110).

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